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RCA electron tube ANNOUNCEMENT

A NEW TUBE..... AN IMPROVED TUBE..... SPECIAL INFORMATION

RADIO CORPORATION OF AMERICA
RCA INTERNATIONAL DIVISION
HARRISON, NEW JERSEY

LICENSEE SERVICE

October 3, 1960

RCA-4601 -- 20-MEGAWATT HARD-TUBE MODULATOR
RCA-4603 -- 1.5-MEGAWATT RF PULSE AMPLIFIER

Gentlemen:

The new RCA-4601 and -4603 super-power triodes feature ceramic-metal and coaxial-electrode construction, thoriated-tungsten filaments, and internal ducts for water cooling.

The 4601, as a hard-tube modulator, is capable of switching pulsed power in the order of 20 megawatts. Its double-ended configuration permits its operation as a cathode-driven rf power amplifier at frequencies up to 200 Mc. The versatile 4601 may also serve as an rf oscillator or an af modulator.

The 4603 is intended for use as a plate-pulsed or grid-pulsed rf power amplifier at frequencies up to 100 Mc with full ratings and at higher frequencies with reduced ratings. These high frequencies are achieved by its shielded-grid construction which enhances the separation of the rf input and rf output circuits. As a plate-pulsed amplifier with duty factor of 0.09 and pulse duration of 3000 microseconds, the 4603 can provide a useful peak power output of 1.5 megawatts at 50 Mc.

RCA-4601 and RCA-4603 are the commercial designations for RCA Developmental Types A-15030 and A-15041, respectively.

Technical bulletins giving ratings, characteristics, typical operating conditions, dimensions, and operating considerations for the 4601 and 4603 are enclosed.

Very truly yours,

R. F. Simokat

R. F. SIMOKAT
Licensee Service

RFS:mlm

4612*

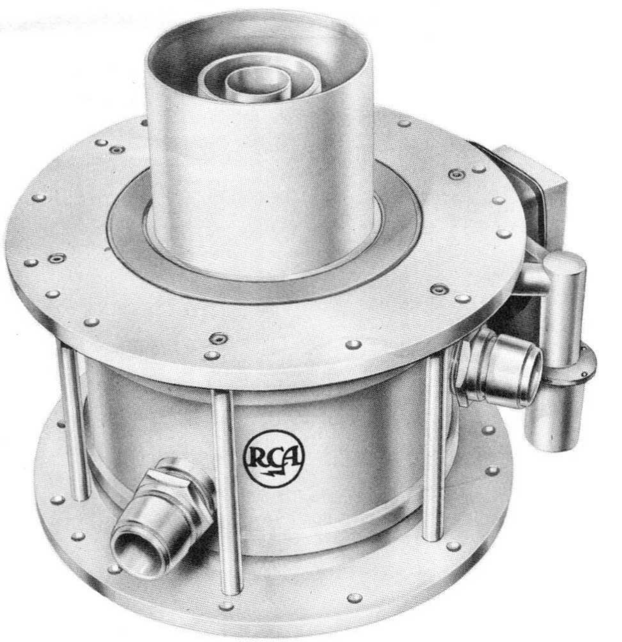
SUPER-POWER TRIODE

Double-Ended Terminal Configuration for Symmetrical Circuitry

0.4 Megawatt as Linear RF Amplifier in Particle Accelerator Service at 475 Mc

Designed to Simplify Broadband Circuitry

RCA-4612 is a water-cooled super-power triode of the ceramic-metal type intended for use as an rf power amplifier at frequencies up to 600 Mc.



Ratings and typical operation are established for the 4612 as a linear rf power amplifier in particle accelerator—or equivalent—service. In this application, the tube will provide a useful peak power output of 0.4 megawatt at 475 Mc with duty factor of 0.16 and pulse duration of 8.33 milliseconds.

The 4612 features a symmetrical double-ended terminal configuration for symmetrical circuitry which places the electrical center of a half-wavelength portion of a resonant cavity in the active region of the tube electrodes. This arrangement provides the following advantages over a single-ended structure: for a given diameter, the double-ended tube can be designed to provide at least twice the power output for a given frequency; for a given power output, the double-ended tube allows operation at higher frequencies.

To simplify the mechanical portion of the double-ended structure, a unique "cork seal" design is used, i.e., the ceramic rings "plug" into either end to insulate the coaxial contact terminals: plate from grid and grid from cathode. This method provides extremely short distances to the active region of the tube. As a result, broadband circuitry may be effectively employed. Fig.1 depicts the terminal and seal structure which combine to give outstanding mechanical stability to the 4612.

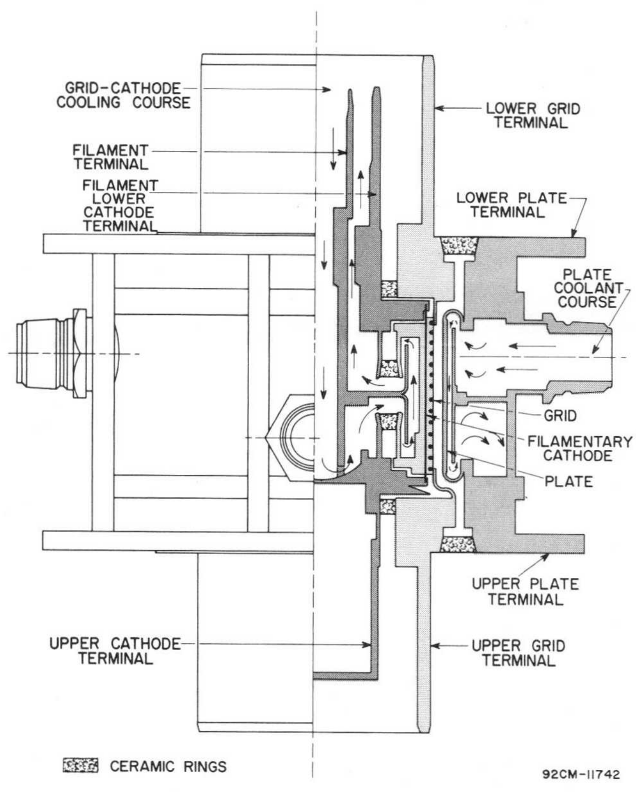


Fig. 1 - Structural Arrangement of Type 4612.

* RCA Commercial Designation for Dev. Type A-15040.

The 4612 also features an internal electrode structure consisting of a precisely spaced cylindrical array of 96 identical triode units, each employing a matrix-type, oxide-coated filamentary cathode to provide high emission, long life and economical operation.

These outstanding advantages and features of the 4612 prompt its use in a wide variety of applications. For preliminary information regarding other possible services, see the sheet attached to this bulletin. For further information on these and requested services, contact your RCA field representative or the nearest District Sales Office.

GENERAL DATA

Electrical:

Filamentary Cathode, multistrand, matrix-type, oxide-coated:		
Current (DC):		
Typical operating value	1800	amp
Maximum value[a]	2000	amp
Maximum value for starting, even momentarily	2000	amp
Minimum time to reach operating current	30	seconds
Minimum time at normal operating current before plate voltage is applied	60	seconds
Voltage (DC):[b]		
Typical value required to obtain 1800 amperes	1.50	volts
Maximum value under any condition	2.0	volts
Pump, electronic high-vacuum type:		
Maximum voltage	3500	volts
Maximum current	5	ma
Direct Interelectrode Capacitances:		
Grid to plate	150	μμf
Grid to cathode	1600	μμf
Plate to cathode	Less than 1.0	μμf

Mechanical:

Operating Position	Tube axis vertical, either end up	
Overall Length	19.5	inches
Maximum Diameter	23.5	inches
Terminal Connections	See *Dimensional Outline*	
Weight (Approx.)	220	lbs

Thermal:

Ceramic-Ring Temperature	150 max.	°C
Metal Surface Temperature	150 max.	°C
Minimum Storage Temperature[c]	-65 min.	°C

Air Cooling:

It is important that the temperature of any external part of the tube not exceed 150° C. In general, forced-air cooling of the ceramic rings and the adjacent contact areas will be required if the tube is used in a confined space without free circulation of air. Under such conditions, provision should be made for blowing an adequate quantity of air across the ceramic rings and adjacent terminal areas to limit their maximum temperature to 150° C.

Water Cooling:

Water-cooling of the grid-cathode structure and the plate is required. The water flow must start before application of any voltages in order to purge the system of bubbles and should continue for several minutes after removal of all voltages. Interlocking of the water flow through each of the cooled elements with all power supplies is recommended to prevent tube damage in case of failure of adequate water flow. The use of distilled water is essential.

Water Flow:

	Typical Flow	*Absolute Minimum Flow*	*Pressure Differential for Typical Flow*[d]
	gpm	*gpm*	*psi*
To Plate:			
Total Flow for Two Parallel Input and Output Coolant Courses:			
For plate dissipation up to 50 kw (Av.)	40	35	5
For plate dissipation of 150 kw (Av.)	100	90	30
For plate dissipation of 300 kw (Av.)	160	150	45
To Grid-Cathode Coolant Course	20	15	15

Resistivity of Water at 25° C:		
Plate	1 min.	megohm-cm
Grid-Cathode	5 min.	megohm-cm
Water Temperature from any outlet	70 max.	°C
External Gas Pressure[e]	65 max.	psig
Maximum Water Pressure at any inlet[e]	90 max.	psig

LINEAR RF POWER AMPLIFIER IN PARTICLE ACCELERATOR SERVICE

For frequencies up to 600 Mc and with "ON" time of 8.33 milliseconds in any 16.6 millisecond interval, and for altitudes up to 5000 ft.

Maximum Ratings, *Absolute-Maximum Values:*

DC PLATE VOLTAGE	16,000 max.	volts
DC GRID VOLTAGE	-150 max.	volts
PEAK PLATE CURRENT	100 max.	amp
PEAK CATHODE CURRENT[f]	120 max.	amp
PLATE DISSIPATION (AVERAGE)	300,000 max.	watts

Typical Operation:

At 475 Mc with pulse waveform shown in Fig.2 and duty factor of 0.166

DC Plate Voltage	12,000	volts
DC Grid Voltage	0	volts
Peak Plate Current	90	amp
Peak Cathode Current[f]	100	amp
Peak Driver Power Output[g]	25,000	watts
Useful Peak Power Output	300,000	watts

[a] The specified maximum filament current is a maximum rating which should not be exceeded, even momentarily, during operation of the tube. The life of the tube can be conserved by operating the filament at the lowest current which will enable the tube to provide the desired power output. Because the filament when operated near the maximum value usually provides emission in excess of any requirements within the tube ratings, the filament current should be reduced to a value that will give adequate but not excessive emission for any particular application. Good regulation of the filament current is, in general, economically advantageous from the viewpoint of tube life.

[b] Measured between KL and KU (See *Terminal Diagram*).

[c] The tube coolant ducts must be free of water before storage or shipment of the tube to prevent damage from freezing.

[d] Measured directly across cooled element for the indicated typical flow.

[e] With gauge located in an area where the maximum pressure external to the gauge is one atmosphere absolute.

[f] Peak or average cathode current is the total of the peak or average plate current and the peak or average rectified grid current. (Pulses are generally not coincident, hence they cannot be added arithmetically.)

[g] Driver power output includes circuit losses and is the actual power measured at the input to the grid circuit. It will vary depending upon the frequency of operation and the circuit used.

DEFINITIONS

Rating System — The maximum ratings in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment-control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

"ON" Time — The sum of duration of all individual pulses which occur during the indicated interval.

Pulse Duration — The time interval between the two points on the pulse at which the instantaneous value is 50% of the peak power value.

Peak Value — The maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

Duty Factor — Product of the pulse duration and repetition rate.

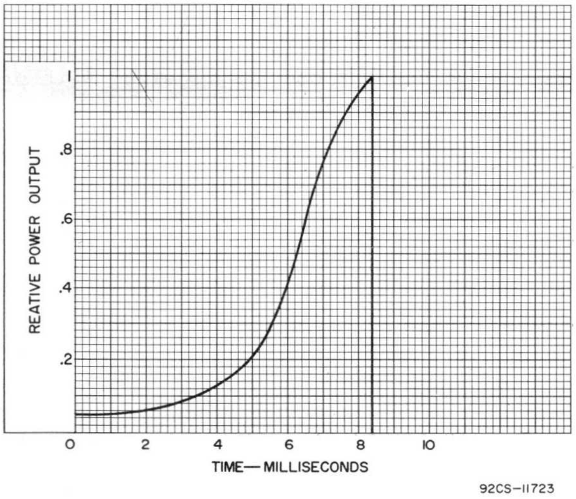


Fig. 2 - Pulse Waveform for Grid-Pulsed Amplifier in Particle Accelerator Service.

GENERAL CONSIDERATIONS

Identification

The serial number which identifies each 4612 and which should be used in any correspondence concerning the tube, is printed on the name plate located on the outside diameter of the plate terminal, as indicated on the *Dimensional Outline*. Other numbers stamped externally on the tube are for purposes of manufacturing records only.

Handling

In transportation, handling, and storage of the 4612, care should be taken to protect the tube from rough handling that would damage the seals or other parts. Care should be taken to avoid distortion or damage to the filament, cathode, or grid terminals by bumping or improperly fitting connectors. NEVER SUPPORT NOR ALLOW THE TUBE TO REST ON THE FILAMENT TERMINALS, UPPER OR LOWER CATHODE TERMINALS, OR THE UPPER OR LOWER GRID TERMINALS. REST THE TUBE ONLY ON THE UPPER OR LOWER PLATE TERMINAL CONTACT SURFACE. (See *Dimensional Outline*). The tube should be lifted only by using eyebolts or equivalent holder through the holes in the upper or lower plate contact surface provided for that purpose. AFTER THE TUBE HAS BEEN SEATED IN THE EQUIPMENT, REMOVE THE EYEBOLTS OR EQUIVALENT HOLDER BEFORE THE TUBE IS PLACED IN OPERATION.

Cleaning

It is recommended that the 4612 be tested upon receipt in the equipment in which it is to be used. Recommended "break-in" treatment is described later. Before the tube is placed in operation, remove any foreign material adhering to it. After the tube has been tested and before it is placed in storage, the internal ducts should be blown free of water especially if the storage temperature will drop below 0° C (32° F). Care should be taken to prevent any foreign matter from entering the water connections at any time. In addition, particular care should be taken to prevent foreign particles from coming in contact with the re-entrant areas at the edge of the ceramic seals. Unless adequately protected by filtered air, these areas collect dirt rapidly due to electrostatic forces and the nature of the air circulation around the tube. As a safeguard, it is recommended that during storage the 4612 be completely enclosed in a protective plastic bag, and then sealed in the container in which it was received.

Tube cleanliness is an important consideration. As with other high-voltage equipment, it is essential that external parts of the 4612 be kept free from accumulated dirt and moisture to minimize surface leakage and the possibility of corona and external arc-over. Make it a regular practice to wipe dirt from the external parts of the tube about twice a month or more frequently if necessary to keep the tube clean.

MECHANICAL CONSIDERATIONS

Mounting

The mounting used for the 4612 should hold the tube in a vertical position. The entire weight of the tube should be supported by the upper or lower plate terminal contact surfaces. (See *Dimensional Outline*). Provision should be made to avoid subjecting the tube to appreciable shock or vibration.

Connections

Because of the low-voltage, high-current filament, it is recommended that the filament connectors be kept short to minimize voltage drop. The use of coaxial filament connectors is recommended. The connector for the coaxial terminals of the filament should be of the coil-spring, pressure-contact type. (See *Detail of Filament Terminals*). The filament connectors should make firm, large-surface contact. Caution should be exercised when assembling or disassembling the filament connectors so that the filament terminals are not loosened. To avoid loosening of filament terminals, always rotate connectors clockwise when viewing tube from filament-terminals end, both for assembly and disassembly of filament connectors.

Flexible connectors of the spring-contact type are also required for the grid terminals and cathode terminals and their associated cavities.

When power is applied to the tube, there may be some motion of various parts of the tube and associated circuitry due to thermal expansion. In order that no undue stress is placed on the ceramic-metal seals of the tube, the terminal connectors should be flexible. The connecting leads and water hoses should be installed so that the slack portion does not come close to or approach the body of the tube.

When connecting or disconnecting the water hoses and the electrical connections, it is essential that no undue stress be placed on the seals. The direction of water flow must be as indicated on the Upper Terminal End View for the plate coolant course and *Detail of Filament Terminals* for grid-cathode coolant course.

COOLING CONSIDERATIONS

System

The water cooling system consists, in general, of a source of water, a water regeneration loop, a heat exchanger, a feed-pipe system which carries the water to the plate and grid-cathode cooling courses of the tube, and provision for interlocking the water flow through each of the coolant courses with the power supplies.

The low-volume water-supply to the grid-cathode coolant courses requires a very high quality water (minimum resistivity of 5 megohm-centimeters), whereas the high-volume water supply to the plate coolant course requires only high-quality water (minimum resistivity of 1 megohm-centimeter). Therefore, it is economically feasible to tap a portion of the water to the plate coolant course, and by additional filtering, provide the water supply to the grid-cathode coolant course.

It is essential that the insulating tubing between the cooling-system piping and each of the coolant courses have good insulating qualities and be of sufficient length to minimize leakage currents and/or electrolysis effects. The minimum plate-water-column resistance should be 10 megohms at 25° C.

The piping system must be arranged so that direction of water flow through each cooled electrode is as specified above under *Connections* to insure adequate cooling. Series or parallel arrangement of the water ducts is permissible so long as the specified flow, pressure and outlet temperature ratings are observed. *Caution: The feed-pipe system should be so designed that all of the water indicated by the flow-meter at each outlet passes through the associated water duct within the tube, and is not shunted inadvertently by any other path.*

Precautions

Proper functioning of the water system is of the utmost importance. Even a momentary failure of the water flow will damage the tube. In fact, without water flow, the heat of the filament alone is sufficient to cause serious harm. It is, therefore, necessary to provide a method of preventing operation of the tube in case the water supply should fail. This may be done by the use of water-flow interlocks which open the power supplies when the flow through any element is insufficient or ceases. The water flow must start before application of any voltages and preferably should continue for several seconds after removal of all voltages.

The absolute-minimum water flow required through the plate coolant courses and to the grid-cathode coolant courses together with pressure differentials across the cooled elements, is given in the *General Data*. The use of an outlet water thermometer and a water flow meter at each of the outlets is recommended. Under no circumstances should the temperature of the water from any outlet exceed the maximum value given for the water in the *General Data*.

In spite of the usual precautions taken to eliminate contamination of the water by oil, dust, etc., some impurities are likely to enter the water. The use of a strainer with at least 60-mesh screen is recommended in the water-supply line as near to the tube as possible to trap any foreign particles likely to impair the water-flow through the tube ducts. Also, a regeneration loop followed by a submicron filter should be employed.

Use of Water

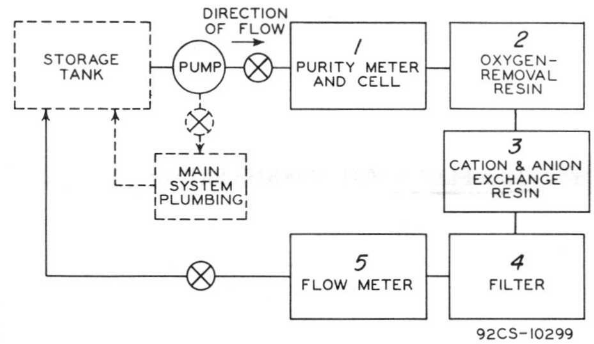
In the design of a cooling system utilizing water, it is recommended that the system be of the closed type utilizing distilled water. When pure distilled water is introduced into the system, it becomes contaminated by the system components. For example, in a copper-plumbing system the presence of oxygen and carbon dioxide enhances the dissolution of copper into the system water and its subsequent deposition as copper oxide on the hot plate structure of the tube. The rate of formation of this oxide is dependent on the operating plate dissipation of the tube and the amount of copper, oxygen, and carbon dioxide in the water system. Eventually the amount of precipitated oxide may reach a magnitude such that it will thermally insulate the plate from the water and cause the plate to crack because of insufficient cooling.

It is essential (1) that high-quality water be used to fill the system initially, (2) that provision be made for continuous regeneration (purification) of the system water, and (3) that steps be taken to eliminate insofar as possible the sources of contamination. These requirements are necessary to prevent scale formation, corrosion, and excessive electrolysis. Any one of these conditions can greatly reduce tube life. Corrosion and electrolysis contribute to water contamination and can destroy the tube elements, ducts, and fittings.

Some of the contaminants which are conducive to scale formation include oxygen, carbon dioxide, metal ions, and organic solids. The most thorough means for determining the quality of the system water is by a complete chemical analysis. Such an analysis, although difficult, can be performed by a qualified testing laboratory.

A suggested method of achieving suitable quality of the system water is as follows:

1. Use only distilled water to fill the system. The use of distilled water avoids the introduction of organic or colloidal matter that may exist in de-ionized water.
2. To maintain acceptable quality, continuous regeneration (purification) of the water in the system is necessary. This regeneration can be achieved by passing a portion of the flow through suitable ion exchangers and filters. A recommended regeneration loop is shown in Fig.3. Operation of the regeneration loop should be in accord with the recommendations of the manufacturer of each component with regard to pressure, temperature, and maintenance of the individual components.
3. The efficiency and life of the regeneration loop may be improved by retarding the rate of recontamination of the water by foreign matter. Pipe lines should be connected to the water tank below the water level to minimize turbulence and thus to decrease absorption of gases by the water. It is also to be noted that any contaminating gases should be excluded from the storage tank in the closed water system. This should be done by replacing the air with nitrogen under slight pressure.
4. In order to minimize electrolysis, the plate-water-column (water path between plate and ground) resistance should have a value not less than 10 megohms at 25° C.



Block No.	
1.	Resistivity cell (0.01 cell constant) and meter, such as Barnstead PM-18 meter with B-18 cell. This cell and meter are optional test equipment.
2.	Oxygen-removal resin, such as Barnstead No.0810 cartridge, in BD-2 Bantam Demineralizer.
3.	Mixed bed demineralizer, such as Barnstead Type M Bantam Demineralizer.
4.	Sub-micron filter, such as Barnstead MF-25.
5.	Flow meter.

The above items may be purchased from the Barnstead Still & Sterilizer Co., 2 Lanesville Terrace, Boston 31, Mass.

Fig.3 - Block Diagram of a Water Regeneration Loop.

Although an accurate chemical analysis is the absolute method of checking system water quality, a measurement of the water resistivity may be used as a guide to determine whether or not ionized contaminants are excessive. Dissolved gases, metals, and other contaminants reduce the resistivity of the water in varying amounts. Some contaminants, such as oxygen, greatly reduce the resistivity. However, if the specific resistivity of the water falls below 1 megohm-cm at 25° C, it can be assumed that the contaminants are excessive. Also, if the pH of the water is outside of the range from 6.8 to 7.2 the water contains excessive contaminants.

The value given for plate-water-column resistance in item 4 above and the value for specific resistivity of the water indicated in the preceding paragraph are minimum values. In practice, higher values should be realized with a properly operating regeneration loop. For example, the specific resistivity can have a theoretical maximum value of 18 megohm-cm at 25° C.

The value of plate-water-column resistance and the value for specific resistivity of the water measured at a temperature other than 25° C can be converted approximately to the corresponding 25° C values for comparison with the specified values by means of the following equation:

$$R_{25^o} = R_{t_1}\ [1 + 0.025\ (t_1 - 25)] \qquad (1)$$

where:

R_{25^o} is the converted value of the measured resistance of resistivity.

R_{t_1} is the measured resistance or resistivity at water temperature t_1.

t_1 is the water temperature in degrees Centigrade at which the resistance or resistivity is measured.

ELECTRICAL CONSIDERATIONS

Plate Dissipation Calculation

An approximated value of the plate dissipation may be calculated from the following equation:

$$P_{watts} = n\ (t_o - t_i) \times 264 \qquad (2)$$

In which t_i is the temperature of the water at the inlet to plate in degrees Centigrade, t_o is the temperature of the water at the outlet from plate in degrees Centigrade, and n is the number of gallons per minute of total flow through the two parallel plate cooling courses.

In the above equations, the values for t_o and t_i are read on thermometers installed in the pipe lines as close to the tube as possible.

Protection Circuits

The plate voltage at which this tube operates is extremely dangerous. Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel cannot possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

An interlocking relay system should be provided to prevent application of the plate voltage pulse prior to the application of sufficient bias voltage and/or rf drive power to the grid.

A time-delay relay should be provided in the plate supply circuit, the grid supply circuit, and the rf drive circuit to prevent application of voltage until the filament has reached its normal operating temperature. (See *Minimum time at normal operating current* in *General Data*).

A high-speed electronic protective circuit may be required to remove the plate voltage within 10 microseconds in the event of abnormal operation such as internal arcing. To determine the necessity of this protection in addition to the usual circuit breakers, the "tin-foil" test described below is recommended. When the plate modulation system passes this test, simple interruption of the modulator trigger following the occurrence of a fault will be adequate.

The following tests involve extremely dangerous high voltages and should be made only after suitable precaution and safety measures have been taken to protect personnel.

A test of the effectiveness of the protection device or of the need for such a device may be made as follows: Disconnect the plate lead from the 4612. Fasten to the "disconnected" plate lead from the modulation system a small sheet (approximately 2" x 2") of thin aluminum foil, such as ordinary household foil. Then discharge the full rated voltage of the plate modulation system by bringing a grounding rod slowly up to the piece of metal foil. The protective device is not needed when the discharge of the plate modulation system produces not more than a pinhole in the foil attached to the plate modulation system lead.

The protective device employed to remove the plate voltage in any installation must be approved by an RCA field representative or by the nearest District Sales Office. In addition, the rf-power-input transmission line should be provided with VSWR protection to remove drive power and plate voltage within 10 milliseconds in the event of abnormal changes in input VSWR during operation.

Circuit Returns

Circuit return from the plate should be made to the output-circuit-return grid terminals, identified on the tube symbol as GLO and GUO. Connection to the output-circuit-return terminals should be made by a system of fingers bearing on the grid output terminal contact areas.

Precautions

For stable operation it is advisable to maintain the drive pulse at the operating level during the entire operation of the plate voltage pulse. The drive pulse should start ahead of the plate pulse, and should remain on after the end of the plate pulse to insure this condition. However, the drive-pulse length should not exceed the plate-pulse length by more than 10%.

At the higher frequencies, uneven heating of the seals may be encountered because of circuit arrangement. Such effects should be minimized through proper circuit design.

Filaments

The 96 interconnected matrix-oxide filaments in the 4612 constitute the filamentary cathode.

A filament starter should be used to raise the filament voltage and current gradually in order to limit the high initial surge of current through the filament when the circuit is first closed. The starter may be either a system of time-delay relays cutting resistance or reactance out of the circuit, a high-reactance filament transformer, or an adjustable autotransformer. Regardless of the method of control, it is important that the filament starting current never exceed a value of 2000 amperes, even momentarily.

The life of the filament can be conserved by operating it at the lowest filament current which will give adequate but not excessive emission to enable the 4612 to give the desired power output. Because the filament when operated near the maximum value of current provides emission in excess of any requirements within tube ratings, it is recommended that the filament current be reduced to a value that will give adequate but not excessive emission for any particular application. Good regulation of the filament current is in general economically advantageous from the viewpoint of tube life.

During long or frequent standby periods, the 4612 may be operated at decreased filament voltage to conserve life. It is recommended that the filament current be reduced to 80% of normal during standby periods up to 2 hours. For longer periods, the filament power should be turned off.

Electronic High-Vacuum Pump

An electronic high-vacuum pump is permanently attached to the tube to maintain a clean, high vacuum in the tube under all conditions. (See *Dimensional Outline*). The pump uses a cold cathode gaseous discharge in a magnetic field to sputter titanium from a titanium cathode plate. Pumping is achieved by chemical combination with the sputtered titanium and by ion "burial" in the titanium. Self-regulation of the titanium consumption and long life are achieved because the sputtering rate is a linear function of pressure. This action is accomplished by the application of a suitable electric potential and permanent magnetic field to the pump.

Since this pump is attached to the plate terminal of the tube it is necessary that its power supply be insulated for plate potential and, in addition, its primary power should be supplied by a suitable isolation transformer. This power supply should also provide adequate metering to permit monitoring of gas currents from several microamperes to several milliamperes.

Utilization of the permanently attached electronic high-vacuum pump will provide maximum reliability, but is not necessary for normal tube operation.

Driver

The value of driver power output given in the tabulated data (See *Typical Operation* under *Linear RF Power Amplifier in Particle Accelerator Service*) represents approximately the actual driving power required at the specified frequency. At higher frequencies, more driving power may be necessary because of increased tube and circuit losses. In all cases, however, the driver stage should be designed to provide an excess of power over that indicated under the typical operating conditions to take care of variations in line voltage, in components, in initial tube characteristics, in tube characteristics during life, and transmission-line mismatches.

Break-In Procedure

The following "break-in" treatment should be given to a new 4612 before it is placed in service. The treatment should also be given in equipment in which tube is to be used when new circuits are tested or when adjustments are made.

Step 1: Make sure that the water system and protective devices are functioning properly.

Step 2: With no other voltages on tube, apply current to the filament in the normal manner and operate at the prescribed typical operating filament current for 15 minutes.

Step 3: Apply reduced value of rf drive power (approximately three-quarters normal drive power) for 15 minutes.

Step 4: Apply reduced value of positive-pulse plate voltage (approximately one-half normal voltage) for several minutes until stable performance is obtained.

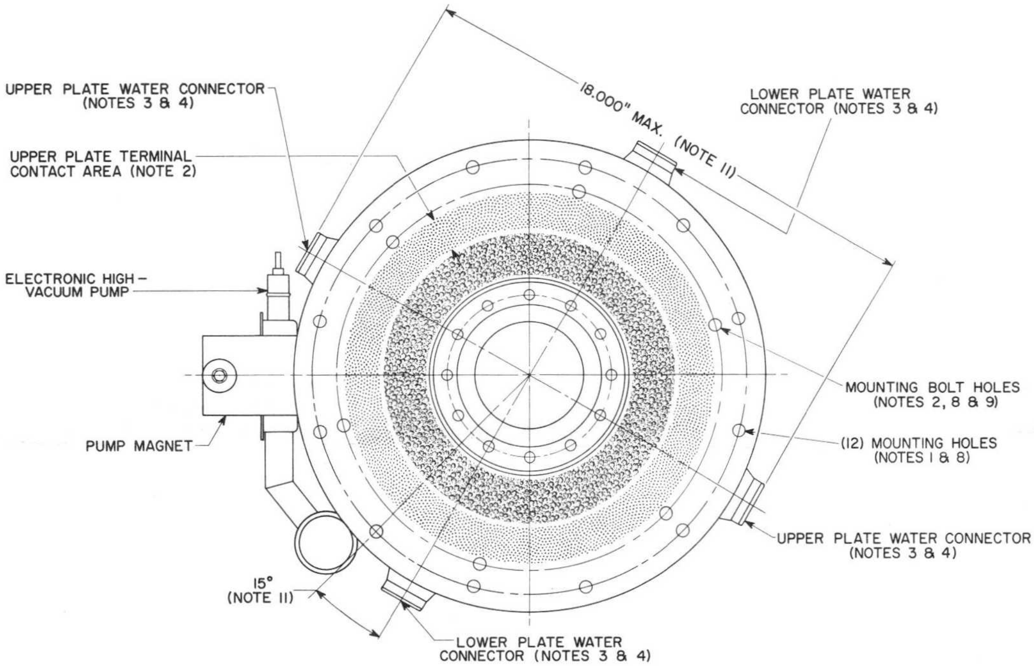
Step 5: Increase rf drive power to normal.

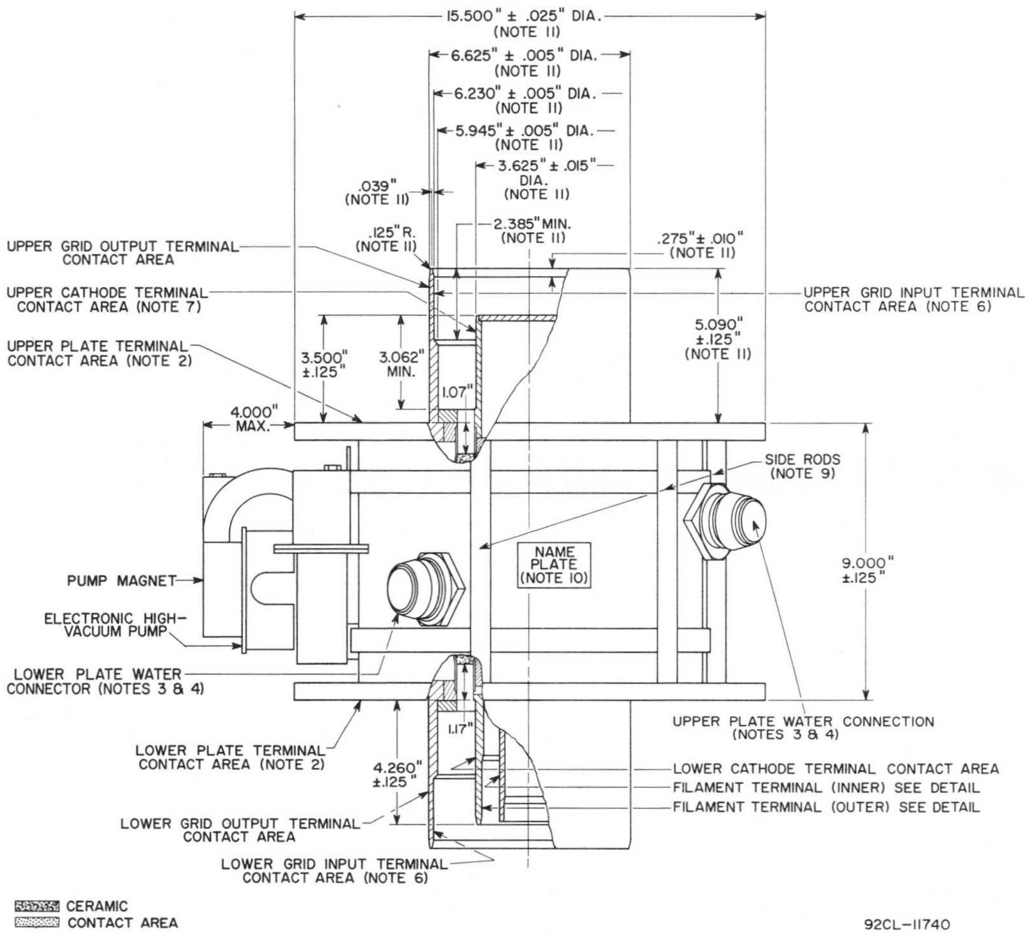
Caution: During this step it is particularly important that the high-speed electronic protective devices be functioning properly to protect against any abnormal conditions.

Step 6: Increase plate voltage to normal, gradually or in steps. Operate the tube for several minutes until stable performance is obtained at each plate voltage level.

After giving the 4612 the above treatment and after it is operating normally to give the desired output, it is suggested that the readings of the meters and flow indicators as well as the control settings be logged.

DIMENSIONAL OUTLINE





NOTES FOR DIMENSIONAL OUTLINE

NOTE 1: TWELVE (12) MOUNTING HOLES EQUALLY SPACED ON A BOLT CIRCLE OF 14.250" DIAMETER. THE HOLES ARE 0.437" DIAMETER.

NOTE 2: CONTACT OF THE UPPER AND LOWER PLATE TERMINAL CONTACT AREAS SHOULD BE MADE AT A DIAMETER GREATER THAN 9.750" OR LESS THAN 12.200". (THIS CLEARS THE MOUNTING BOLT HOLES LOCATED ON A BOLT CIRCLE OF 12.750" DIAMETER).

NOTE 3: THE PLATE WATER CONNECTORS ARE HANSEN PLUGS No.12-T-46. THE FITTINGS MAY BE OBTAINED FROM THE HANSEN MANUFACTURING COMPANY, 4031 WEST 150TH STREET, CLEVELAND 11, OHIO. THE PLUGS ARE LOCATED 90° APART AND ARE ALTERNATED SO THAT TWO UPPER PLATE CONNECTORS, 180° APART, ARE CLOSER TO THE UPPER PLATE TERMINAL AND THE TWO LOWER PLATE CONNECTORS, 180° APART, ARE CLOSER TO THE LOWER PLATE TERMINAL.

NOTE 4: THE PLATE WATER FLOW IS OPTIONAL AS FOLLOWS:

a. FROM BOTH UPPER TO BOTH LOWER PLATE WATER CONNECTORS OR

b. FROM BOTH LOWER TO BOTH UPPER PLATE WATER CONNECTORS.

NOTE 5: TOTAL INDICATOR RUNOUT BETWEEN TERMINALS WILL NOT EXCEED 0.100".

NOTE 6: CIRCUIT CONTACT SHOULD BE MADE ONLY OVER MAXIMUM LENGTH 2.385" OF THE DESIGNATED UPPER OR LOWER-GRID-INPUT TERMINAL.

NOTE 7: CIRCUIT CONTACT SHOULD BE MADE ONLY OVER MAXIMUM LENGTH 3.062" OF THE DESIGNATED UPPER CATHODE TERMINAL.

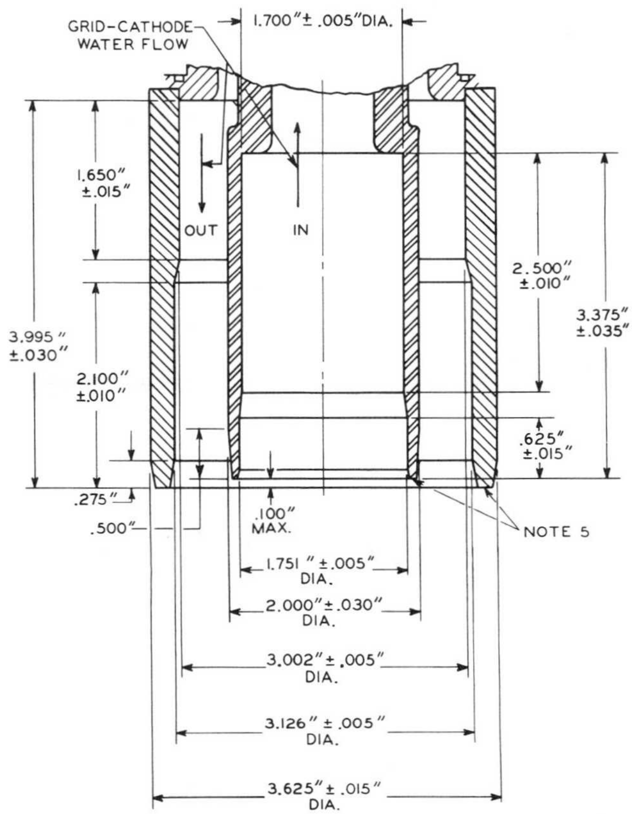
NOTE 8: HOLE LOCATION IN LOWER PLATE ARE DIRECTLY BENEATH THE HOLES IN THE UPPER PLATE.

NOTE 9: DO NOT TAMPER OR TIGHTEN THE (5) MOUNTING BOLTS ON EACH END. THE MOUNTING PLATES ARE PROPERLY LOCATED AND THIS LOCATION OFTEN RESULTS IN SMALL SPACES BETWEEN THE END OF THE SIDE RODS AND THE PLATES.

NOTE 10: NAME PLATE MAY BE LOCATED BETWEEN ANY TWO ADJACENT PLATE WATER CONNECTORS, EXCEPT THAT OCCUPIED BY PUMP.

NOTE 11: DIMENSION APPLIES TO BOTH ENDS OF TUBE.

DETAIL OF FILAMENT TERMINALS



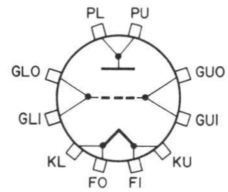
92CS-11743

REFERENCE

M. V. Hoover, *"Advances in the Techniques and Applications of Very-High-Power Grid-Controlled Tubes"*, Proceedings of Internal Convention on Microwave Valves, May, 1958. Proceedings Institution of Electrical Engineers (London), Vol.105, Part B Suppl. No.10 1958.

TERMINAL DIAGRAM

FI: FILAMENT TERMINAL (INNER)
FO: FILAMENT TERMINAL (OUTER)
KU: UPPER CATHODE TERMINAL
KL: LOWER CATHODE TERMINAL
GUI: UPPER GRID INPUT TERMINAL



GUO: UPPER GRID OUTPUT TERMINAL
GLI: LOWER GRID INPUT TERMINAL
GLO: LOWER GRID OUTPUT TERMINAL
PL: LOWER PLATE TERMINAL
PU: UPPER PLATER TERMINAL

For location of respective terminals, see Dimensional Outline

RCA

4612

SUPER-POWER TRIODE

PRELIMINARY TECHNICAL OBJECTIVE DATA

The design of the RCA-4612 lends itself for use as an rf power amplifier, rf linear power amplifier, and rf-pulsed amplifier and should be considered for use in single-sideband service, long-range search radar, pulsed transmission in communications service, and other applications employing high-power rf circuits.

The following typical operations are furnished for guidance purposes only.

DEFINITIONS

"ON" Time — The sum of the duration of all individual pulses which occur during the indicated interval.

Pulse Duration — The time interval between the two points on the pulse at which the instantaneous value is 70% of the peak power value.

Peak Value — The maximum value of a smooth curve through the average of fluctuations over the top portions of the pulse.

Duty Factor — Product of the pulse duration and repetition rate.

"Single-Tone" — Modulation in which the grid input consists of a monofrequency rf signal having constant amplitude. This signal is produced in a single-sideband suppressed-carrier system when a single audio frequency of constant amplitude is applied to the input of the system.

For General Data, Established Ratings, Dimensional Outline, and Operating Considerations, refer to the technical bulletin for the 4612.

* This information applies to contemplated performance and is subject to change. No obligations are assumed as to future performance in this service unless otherwise arranged. For further information regarding this application, contact your RCA field representative or the nearest District Sales Office.

PLATE-AND-GRID PULSED AMPLIFIER*

Typical Operation:

In a cathode-drive circuit, with rectangular waveshape pulses with duration of 30 microseconds at 425 Mc and a duty factor of 0.01.

Peak Positive-Pulse Plate Voltage[a]	25,000	volts
Peak Cathode-to-Grid Voltage[b]	60	volts
Peak Plate Current	400	amp
Peak Cathode Current[c]	500	amp
Peak Driver Power Output[d] (Approx.)	0.2	mw
Useful Peak Power Output (Approx.)	5	mw

LINEAR RF POWER AMPLIFIER*

Single-Sideband Suppressed-Carrier Service

Typical Operation:

With "Single-Tone" modulation and at a frequency of 450 Mc.

DC Plate Voltage	16,000	volts
DC Grid Voltage	0	volts
Zero-Signal DC Plate Current	2.0	amp
Max.-Signal DC Plate Current	90	amp
Max.-Signal DC Grid Current	9.0	amp
Max.-Signal Driver Power Output (Approx.)[d]	30,000	watts
Max.-Signal Useful Power Output (Approx.)	600,000	watts

[a] Under most conditions pressurized cavities will be required for operation at the indicated typical voltages to prevent flash-over at the tube seals.

[b] Preferably obtained from a cathode bias resistor.

[c] Peak or average cathode current is the total of the peak or average plate current and the peak or average rectified grid current. (Pulses are generally not coincident, hence they cannot be added arithmetically).

[d] Driver power output includes circuit losses and is the actual power measured at the input to the grid circuit. It will vary depending upon the frequency of operation and the current used.

Transmitting

RCA electron tube ANNOUNCEMENT

A NEW TUBE..... AN IMPROVED TUBE..... SPECIAL INFORMATION

RADIO CORPORATION OF AMERICA

RCA INTERNATIONAL DIVISION

HARRISON, NEW JERSEY

LICENSEE SERVICE

NEW RCA-4616
SUPER-POWER
BEAM POWER TUBE

February 15, 1963

Gentlemen:

From 2 megawatts of short-pulse power (13-microsecond pulse at 0.004 duty factor) to 275 kilowatts of long-pulse power (2000-microsecond pulse at 0.06 duty factor) — this wide gamut of operation capability is combined in a single tube, the RCA-4616, formerly Dev. No. A2669B. From the famous RCA-6952 — well-proven in the same short-pulse power — emerged this new water-cooled tube with higher dissipation capabilities for expanded pulse operation.

For frequencies primarily between 195 and 600 Mc, these expanded pulse capabilities suggest the use of the 4616 for telemetry, search radar, particle accelerator service, and other applications requiring super-power, rf-pulse circuits. Its matrix-type filamentary cathode requiring low filament power and with a rating for 400-cps excitation also suggest the tube's use in airborne and light-weight portable equipment.

The 4616 retains the outstanding features of the RCA Super-Power "tetrode" line: sturdy mechanical structure consisting of a symmetrical array of unit electron-optical systems surrounding a centrally located plate, low-loss ceramic insulators, integral by-pass capacitors between grid No.2 and cathode, integral coolant ducts for effective cooling of the electrodes, and large-area rf electrode terminals.

Further technical information for the 4616 is in preparation.

Very truly yours,

R.F. Simokat

R.F. SIMOKAT
Licensee Service

RFS:mg

RADIO CORPORATION OF AMERICA
RCA INTERNATIONAL DIVISION
HARRISON, NEW JERSEY

LICENSEE SERVICE

April 4, 1963

RCA-4617
NEW SUPER-POWER UHF TRIODE

Gentlemen:

RCA-4617, formerly Dev. No.A15025B, is a new, uhf, water-cooled, super-power triode for use as a pulsed-rf power amplifier up to 450 Mc in search radar, pulsed transmission in communications or control service, and particle-accelerator service.

Like its prototype, RCA-7835, the 4617 can deliver 8 megawatts of short-pulse power (25-microsecond pulse at 0.01 duty factor). Unlike its prototype, the 4617 contains a matrix-oxide cathode, advantageous in providing higher peak currents in pulse operation at drastically reduced filament power.

The design of the 4617 provides reserve capabilities for even higher peak power outputs at shorter pulse durations. For example, it is expected to deliver 15 megawatts of peak power output with pulses up to 10 microseconds and a duty factor of 0.005.

The 4617 retains the following outstanding features of the RCA Super-Power triode line:

- Double-Ended Coaxial Terminal Configuration for Symmetrical Circuitry
- Extremely Low-Inductance Electrode Terminals for UHF
- Integral Coolant Courses
- High Efficiency
- Advanced Design, Thermally Stable Grid Assembly
- Low-Loss, Rugged, Ceramic Insulators

Further information for the 4617 will be given on request.

Very truly yours,

R. F. Simokat

R. F. SIMOKAT
Licensee Service

RFS/mg

CERMOLOX®

Matrix-Type Unipotential Cathode

Forced-Air Cooled

1350 Watts CW Power Output at 600 MHz

RCA-4618

BEAM POWER TUBE

RCA-4618 is a small, forced-air-cooled uhf beam power tube designed for use in compact aircraft, mobile and stationary equipment. It is rated to frequencies up to 1215 MHz as a linear rf power amplifier in single-sideband suppressed-carrier service, as a plate-modulated rf power amplifier in Class C telephony service, as an rf power amplifier and oscillator in Class C telegraphy service, and as an rf power amplifier in Class C FM telephony service.

The 4618 and variants of its basic design may also be useful in applications such as frequency multipliers, af power amplifiers or modulators, linear rf power amplifiers (AM or television), hard-tube modulators, pulsed-rf amplifiers, regulators, or other special services. Variations in cooling structure or other parameters are also possible. For information on variants, contact your RCA field representative, or the nearest District Sales Office.

The 4618 features the Cermolox construction, a unipotential cathode of the oxide-coated matrix type, and an integral louvered-fin radiator. Details of these features are described in the **Application Guide for RCA Power Tubes, ICE-300•.**

INDEX

• This bulletin is to be used in conjunction with the publication **Application Guide for RCA Power Tubes, ICE-300.** For a copy, write RCA, Commercial Engineering, Harrison, N.J.

GENERAL DATA

Electrical:

Heater for Matrix-Type Oxide-Coated Unipotential Cathode:		
Voltage (ac or dc)	5.5 typical	volts
	6.0 max.	volts
Current at 5.5 volts	17.3	A
Minimum heating time	5	minutes

See further information on the heater in ***Application Guide for RCA Power Tubes, ICE-300;*** *Section V.A.3,* ***Filament or Heater.***

Mu-Factor, Grid No.2 to Grid No.1 for plate volts = 2500, grid No.2 volts = 600, and plate mA = 600	17	
Direct Interelectrode Capacitances:		
Grid No.1 to plate[a]	0.181 max.	pF
Grid No.1 to cathode & heater	42	pF
Plate to cathode & heater[a,b]	0.017 max.	pF
Grid No.1 to grid No.2	55	pF
Grid No.2 to plate	12	pF
Grid No.2 to cathode & heater[b]	1.4 max.	pF

Mechanical:

Operating Position	Any
Overall Length	3.34" max.
Greatest Diameter	3.75" max.
Terminal Connections	*See Dimensional Outline*
Radiator	Integral part of tube
Weight (Approx.)	2 lbs.

Thermal:

Terminal Temperature (Plate, grid No.2, grid No.1, cathode, and heater)	250 max.	°C
Plate-Seal Temperature	250 max.	°C

See Dimensional Outline for temperature-measurement points

LINEAR RF POWER AMPLIFIER, CLASS AB$_1$[c]

Single-Sideband Suppressed-Carrier Service

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2

Maximum CCS Ratings, *Absolute Values:*

	Up to 1215 MHz	
DC PLATE VOLTAGE	3000 max.	volts
DC GRID-No.2 VOLTAGE	1000 max.	volts
MAX.-SIGNAL DC PLATE CURRENT	1.0 max.	A
MAX.-SIGNAL DC GRID-No.1 CURRENT	0.2 max.	A
MAX.-SIGNAL PLATE INPUT	2500 max.	watts
MAX.-SIGNAL GRID-No.2 INPUT	50 max.	watts
PLATE DISSIPATION	1500 max.	watts

Maximum Circuit Values:

Grid-No.1 Circuit Resistance Under Any Condition:

With fixed bias	5000 max.	ohms
With fixed bias (in Class AB$_I$ operation)	Not recommended	
With cathode bias	Not recommended	
Grid-No.2 Circuit Impedance	See note d	
Plate Circuit Impedance	See note e	

Typical CCS Class AB$_I$ "Single-Tone" Operation

	Up to 60 MHz		
DC Plate Voltage	2250	2250	volts
DC Grid No.2 Voltage	700	700	volts
DC Grid-No.1 Voltage	-50	-50	volts
Zero-Signal DC Plate Current	0.2	0.2	A
Zero-Signal DC Grid-No.2 Current	0	0	A
Effective RF Load Resistance	1100	1100	ohms
Max.-Signal DC Plate Current	0.9	1.0	A
Max.-Signal DC Grid-No.2 Current	0.045	0.045	A
Max.-Signal DC Grid-No.1 Current	0	0	A
Max.-Signal Peak RF Grid-No.1 Voltage	50	50	volts
Max.-Signal Driving Power (Approx.)	0	0	watts
Max.-Signal Power Output (Approx.)	1000	1250	watts

PLATE-MODULATED RF POWER AMP.-Class C Telephony[c]

Carrier conditions per tube for use with max. modulation factor of 1.0

Maximum CCS Ratings, *Absolute Values*

	Up to 1215 MHz	
DC PLATE VOLTAGE	2500 max.	volts
DC GRID-No.2 VOLTAGE	1000 max.	volts
DC GRID-No.1 VOLTAGE	-300 max.	volts
DC PLATE CURRENT	0.85 max.	A
DC GRID-No.1 CURRENT	0.2 max.	A
PLATE INPUT	1700 max.	watts
GRID-No.2 INPUT	35 max.	watts
PLATE DISSIPATION	1000 max.	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance:

Under any condition	5000 max.	ohms

Typical CCS Operation in Grid-Drive Circuit at 600 MHz:

DC Plate Voltage	1800	2000	volts
DC Grid-No.2 Voltage	500	500	volts
DC Grid-No.1 Voltage	-75	-75	volts
DC Plate Current	0.75	0.83	A
DC Grid-No.2 Current	0.015	0.015	A
DC Grid-No.1 Current (Approx.)	0.04	0.04	A
Driver Power Output (Approx.)	50	55	watts
Useful Power Output (Approx.)	650	800	watts

FOOTNOTES

[a] With external flat metal shield having diameter of 8", and center hole approximately 3" in diameter provided with spring fingers that connect the shield to grid-No.2 terminal. Shield is located in plane of grid-No.2 terminal perpendicular to the tube axis.

[b] With external flat metal shield having diameter of 8", and center hole approximately 2-3/8" in diameter provided with spring fingers that connect the shield to grid-No.1 terminal. Shield is located in plane of grid-No.1 terminal perpendicular to the tube axis.

[c] See Section V.C. of 1CE-300.

[d] See Section V.B.2 of 1CE-300.

[e] See Section V.B.1 of 1CE-300.

RF POWER AMPLIFIER & OSC. – Class C Telegraphy[c]
and
RF POWER AMPLIFIER – Class C FM Telephony[c]

Maximum CCS Ratings, *Absolute Values:*

	Up to 1215 MHz	
DC PLATE VOLTAGE.	3000 max.	volts
DC GRID-No.2 VOLTAGE. . . .	1000 max.	volts
DC GRID-No.1 VOLTAGE. . . .	-300 max.	volts
DC PLATE CURRENT.	1.0 max.	A
DC GRID-No.1 CURRENT. . . .	0.2 max.	A
PLATE INPUT.	2500 max.	watts
GRID-No.2 INPUT.	50 max.	watts
PLATE DISSIPATION	1500 max.	watts

Typical CCS Operation in Grid-Drive Circuit at 600 MHz:

DC Plate Voltage	2250	2500	volts
DC Grid-No.2 Voltage	500	500	volts
DC Grid-No.1 Voltage	-75	-75	volts
DC Plate Current	0.9	1.0	A
DC Grid-No.2 Current.	0.02	0.02	A
DC Grid-No.1 Current (Approx.).	0.07	0.07	A
Output Circuit Efficiency (Approx.).	90	90	%
Driver Power Output (Approx.).	70	75	watts
Useful Power Output (Approx.).	1050	1350	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance:
Under any condition. . . . . . 5000 max. ohms

CHARACTERISTICS RANGE VALUES

	Note	*Min.*	*Max.*	
1. Heater current	1	16.3	18.2	A
2. Direct Interelectrode Capacitances:				
Grid No.1 to plate. . .	2	-	0.181	pF
Grid No.1 to cathode & heater.	-	37	46	pF
Plate to cathode & heater.	2,3	-	0.017	pF
Grid No.1 to grid No.2	-	46	62	pF
Grid No.2 to plate. . .	-	9.9	13.1	pF
Grid No.2 to cathode & heater.	3	-	1.4	pF
3. Mu-Factor, Grid No.2 to Grid No.1	1,4	8	24	
4. Cutoff Grid-No.1 Voltage	1,5	-	-140	volts
5. Grid-No.2 Current	1,6	-28	+12	mA
6. Useful Power Output. . .	1,7	1000	-	watts
7. Low-Frequency Vibration	1,8	-	500	mV
8. High-Frequency Vibration	9	(See Note 9)		

Note 1: With 5.5 volts ac on heater.

Note 2: With external flat metal shield having diameter of 8", and center hole approximately 3" in diameter provided with spring fingers that connect the shield to grid-No.2 terminal. Shield is located in plane of grid-No.2 terminal perpendicular to the tube axis.

Note 3: With external flat metal shield having diameter of 8", and center hole approximately 2-3/8" in diameter provided with spring fingers that connect the shield to grid-No.1 terminal. Shield is located in plane of grid-No.1 terminal perpendicular to the tube axis.

Note 4: With dc plate voltage of 2500 volts, dc grid-No.2 voltage of 600 volts, and dc grid-No.1 voltage adjusted to give a plate current of 0.6 amperes.

Note 5: With dc plate voltage of 3000 volts, dc grid-No.2 voltage of 1000 volts, and dc grid-No.1 voltage adjusted to give a plate current of 20 mA.

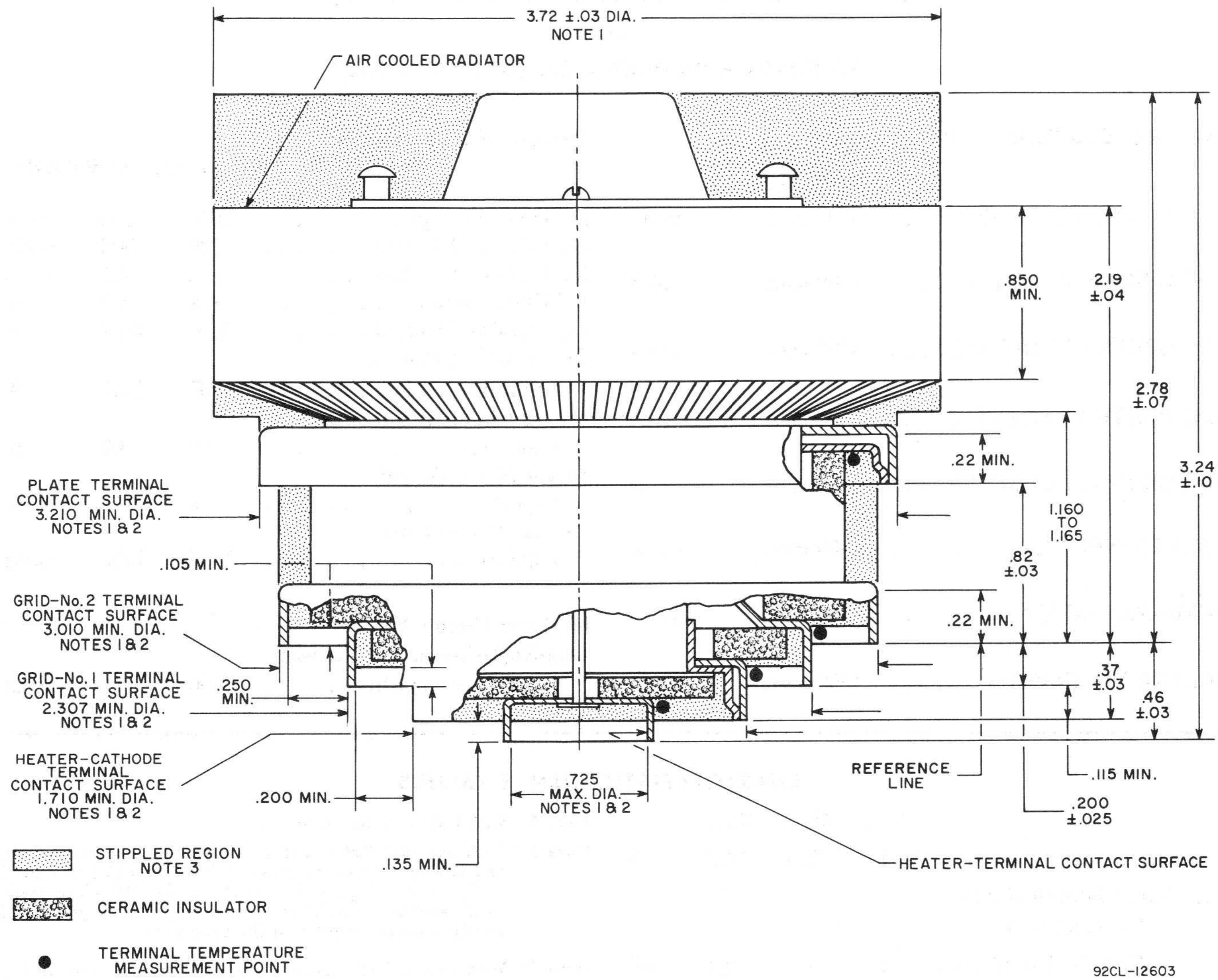
Note 6: With dc plate voltage of 2500 volts, dc grid-No.2 voltage of 500 volts, and dc grid-No.1 voltage adjusted to give a plate current of 0.6 ampere.

Note 7: In a CW cathode-driven amplifier circuit at 600 MHz and for conditions: dc plate voltage at 2500 volts, dc grid-No.2 voltage of 700 volts, and dc grid-No.1 voltage adjusted to give a plate current of 1.0 ampere.

Note 8: As specified in MIL-E-IE Test Method 1031, and with plate voltage of 450 volts, grid-No.2 voltage of 300 volts, grid-No.1 voltage varied to give a plate current of 10 mA, and plate load resistor of 2000 ohms.

Note 9: As specified in MIL-E-IE Test Method 1031.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

NOTE 1: Concentricity between the various diameters is such that the tube will enter a gauge having suitably spaced concentric apertures and posts of the following diameters:

a. Radiator Band – 3.7805

b. Plate Terminal – 3.2605

c. Grid-No.2 Terminal – 3.0605

d. Grid-No.1 Terminal – 2.3375

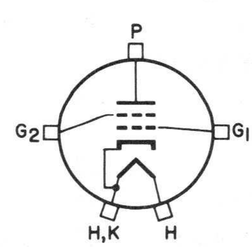
e. Heater-Cathode Terminal – 1.7445

f. Heater Terminal – 0.6945

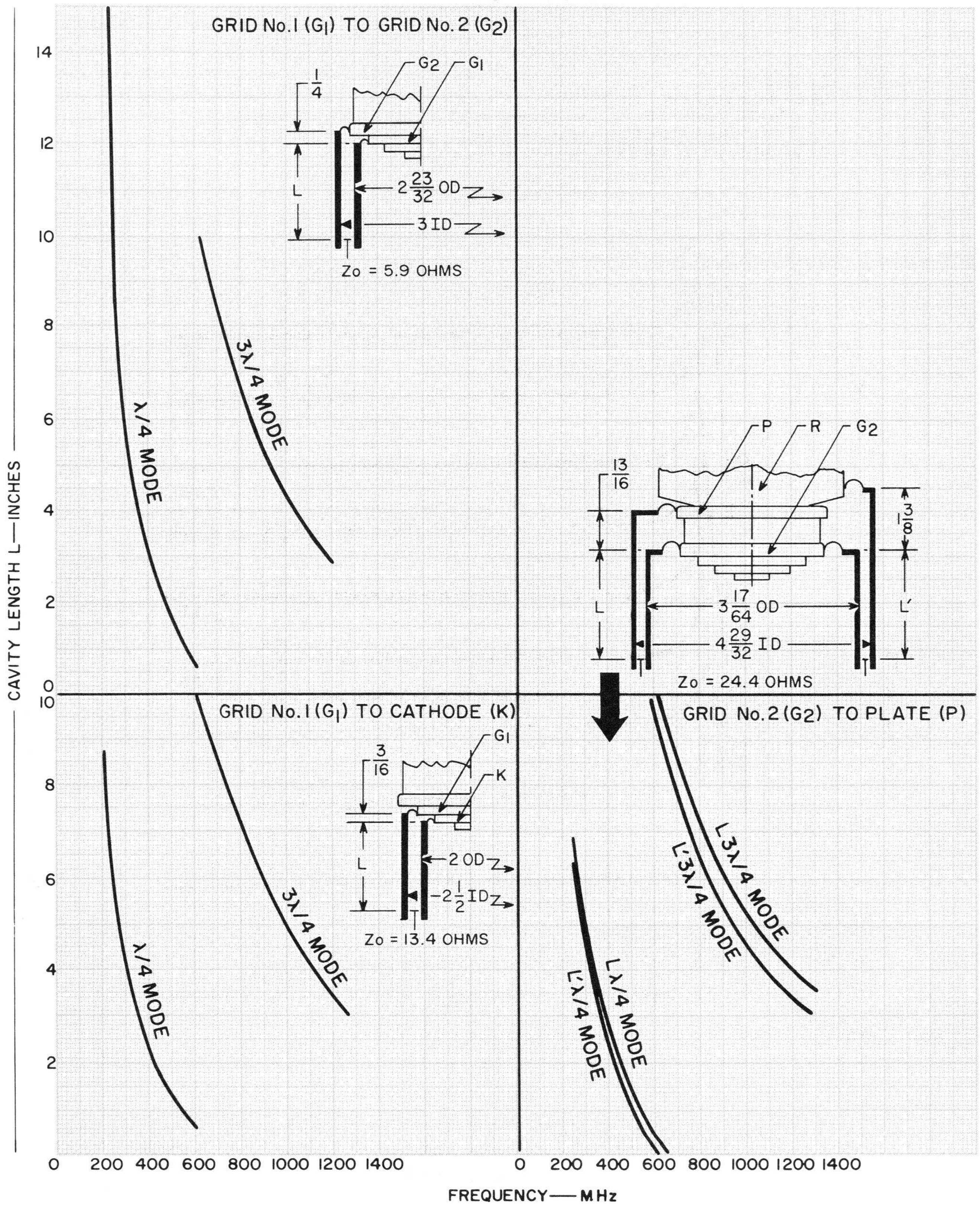
NOTE 2: The diameter of the terminal is held to the indicated value only over the contact surface length. The contact surface length of the heater-cathode and grid-No.1 terminals extends from the edge of its terminal to the plane coincident with the edge of the adjacent larger terminal.

NOTE 3: Keep all stippled regions clear. Do not allow contacts or circuit components to protrude into these annular volumes. Diameters of stippled areas above air-cooled radiator, plate terminal contact surface, and grid-No.2 terminal contact surface shall not be greater than its associated diameter.

TERMINAL DIAGRAM

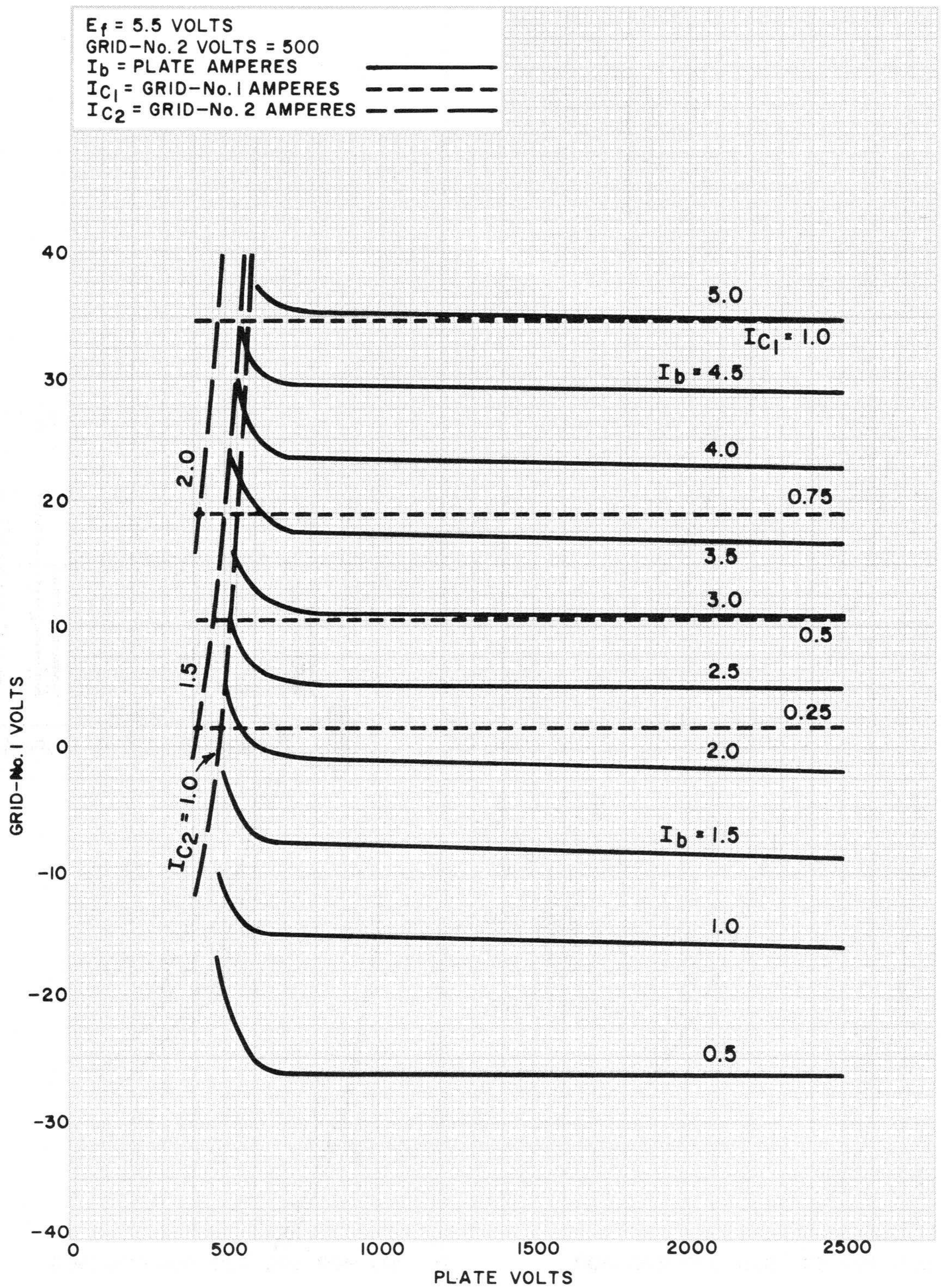


TUNING CHARACTERISTICS



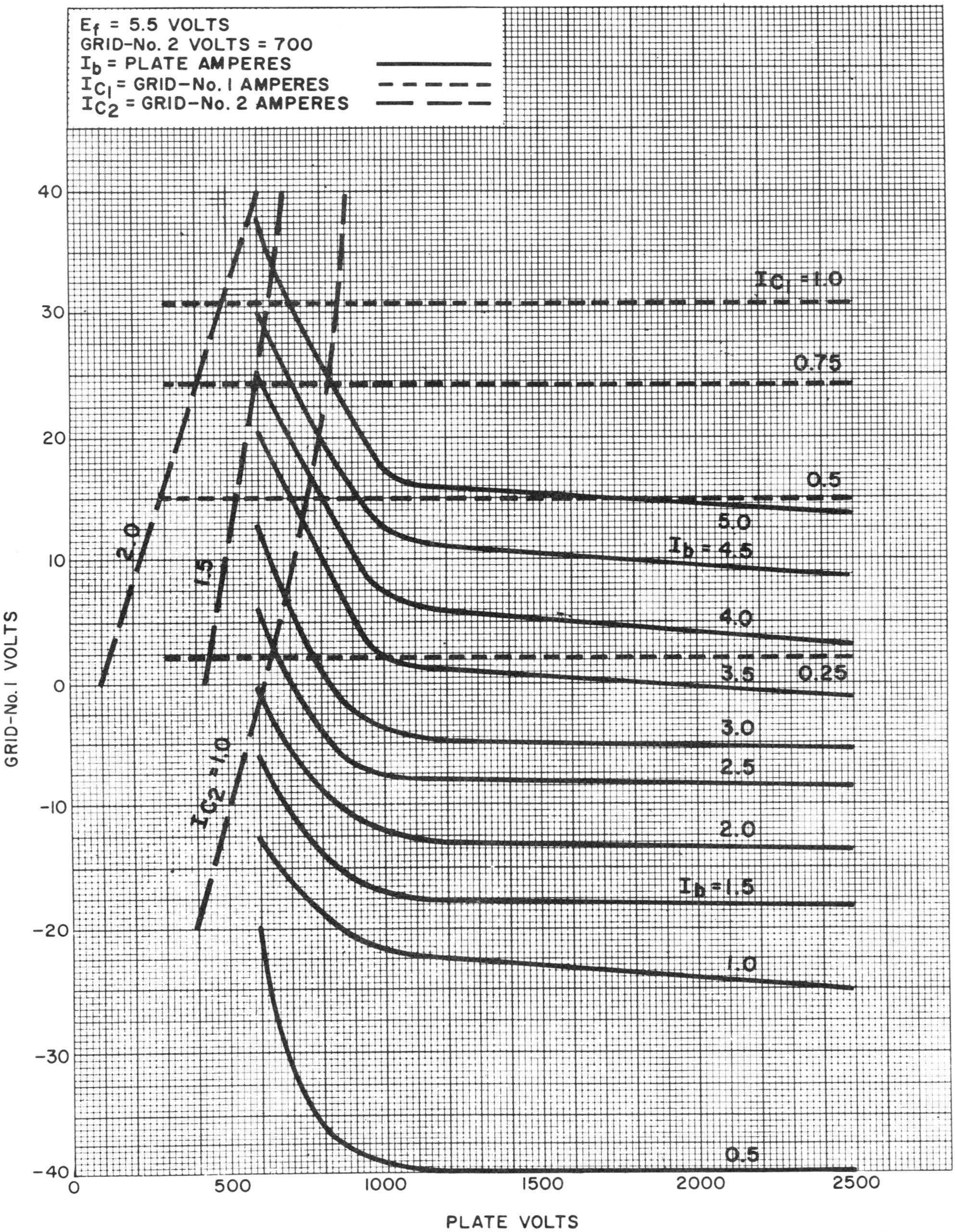
92CM-12591

TYPICAL CONSTANT-CURRENT CHARACTERISTICS
With Grid-No.2 Volts = 500



92CM-9744R1

TYPICAL CONSTANT-CURRENT CHARACTERISTICS
With Grid-No.2 Volts = 700



92CM-9752R1

FORCED-AIR COOLING

Air Flow:

Through radiator – Adequate air flow to limit the plate-seal temperature to 250° C should be delivered by a blower, such as Rotron* AXIMAX 2, KS-408, or equivalent, through the radiator before and during the application of heater, plate, grid-No.2, and grid No.1 voltages. See graph, Typical Cooling Characteristics.

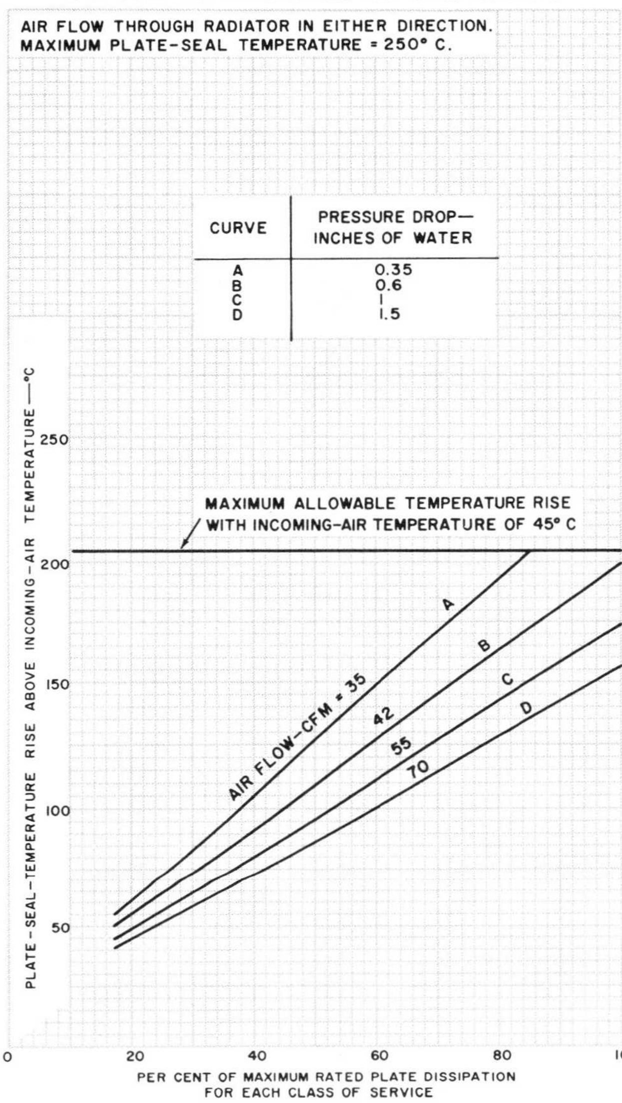
To Plate, Grid-No.2, Grid-No.1, Heater-Cathode, and Heater Terminals – A sufficient quantity of air should be allowed to flow past each of these terminals so that their temperature does not exceed the specified maximum value of 250° C.

During Standby Operation – Cooling air is required to the Heater-Cathode and Heater Terminals when only heater voltage is applied to the tube.

During Shutdown Operation – Air flow should continue for a few minutes after all electrode power is removed.

*Rotron Mfg. Co., Inc., Woodstock, N.Y.

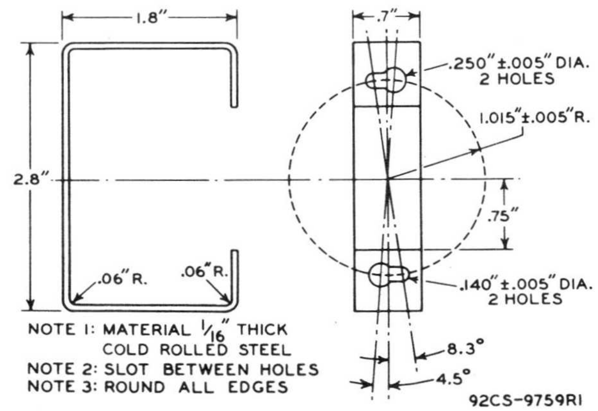
TYPICAL COOLING CHARACTERISTICS



CURVE	PRESSURE DROP— INCHES OF WATER
A	0.35
B	0.6
C	1
D	1.5

92CM-9737R1

TUBE EXTRACTOR
Suggested Design

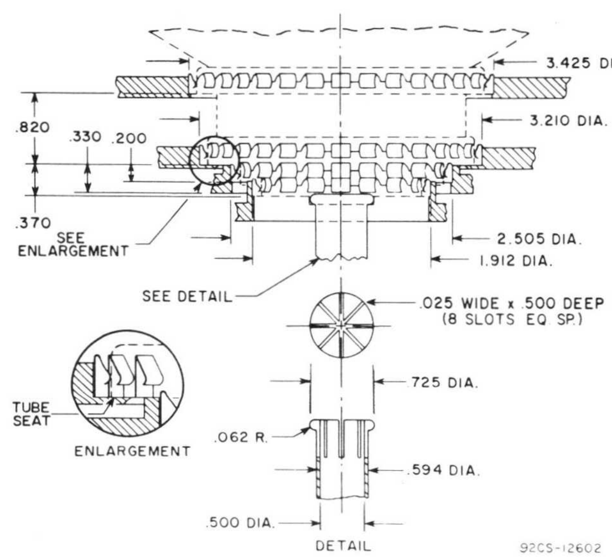


92CS-9759R1

MOUNTING

See the preferred mounting arrangement below. See section III.C.3.a of 1CE-300 for a description of the fixed method of mounting. The adjustable method is not recommended for the 4618.

PREFERRED MOUNTING ARRANGEMENT



92CS-12602

DIMENSIONS IN INCHES

UHF Grid-Drive Operation
Distributed Amplifier Service to 500 Mc
Matrix-type Unipotential Cathode
300 Watts UHF TV Output at 890 Mc
410 Watts PEP Output at 30 Mc
Forced-Air Cooled

RCA-4624

BEAM POWER TUBE

RCA-4624▲ is a compact forced-air-cooled ceramic-metal beam power tube designed especially for use in broadband uhf amplifier service in stationary and portable equipment. It is rated as an rf power amplifier in Class B television service and as a linear rf power amplifier in single-sideband service.

Grid-drive operation of the 4624 becomes practical at uhf frequencies because of the internal grid-No.2-to-cathode bypass capacitor and "cross-over" of the grid No.1 and cathode terminals. The large-area pins and base configuration together give low lead inductance and low input capacitance for uhf service. In addition, the three grid-No.1 leads to separate pins accommodate a split-input circuit for distributed amplifier service.

Additional features of the 4624 include a matrix-type unipotential cathode, precision-aligned grids, and an integral louvered-fin radiator. Details of these features are described in the **Application Guide for RCA Power Tubes,** 1CE-300.

▲ Formerly Dev. No. A2733.

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This bulletin is to be used in conjunction with the publication **Application Guide for RCA Power Tubes,** 1CE-300. For a copy, write RCA, Commercial Engineering, Harrison, N.J.

GENERAL DATA

Electrical:

Unipotential Cathode, Matrix Type:		
Heater voltage (ac or dc)	6.3	volts
Heater current at 6.3 volts	3.5	amp
Minimum heating time	1	minute

See further information on the filament in **Application Guide for RCA Power Tubes,** 1CE-300; *Section V.A.3,* **Filament or Heater.**

Mu-Factor, Grid No.2 to Grid No.1 for plate volts = 450, grid-No.2 volts = 325, and plate amp. = 1.2	12	
Direct Interelectrode Capacitances:		
Grid No.1 to plate	0.062 max.	pf
Grid No.1 to cathode	20	pf
Plate to cathode	6.2 max.	pf
Grid No.1 to grid No.2	19	pf
Grid No.2 to plate	2.2	pf
Grid No.2 to cathode	590 max.	pf

Mechanical:

Operating Position	Any
Overall Length	2.19" max.
Greatest Diameter	2.26" max.
Terminal Connections	*See Dimensional Outline*
Radiator	Integral part of tube
Weight (Approx.)	4.5 oz.

Thermal:

Terminal Temperature (Plate, grid No.2, grid No.1, cathode-heater, and heater)	250 max.	°C
Plate-Core Temperature	250 max.	°C

See Dimensional Outline for temperature-measurement points

RF POWER AMPLIFIER --
Class B Television Service[a]

Synchronizing-level conditions per tube unless otherwise specified

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC PLATE VOLTAGE	2200 max.	volts
DC GRID-No.2 VOLTAGE	400 max.	volts
DC PLATE CURRENT	375 max.	ma
GRID-No.1 CURRENT	100 max.	ma
PLATE DISSIPATION	400 max.	watts
GRID-No.2 INPUT	8 max.	watts

Typical CCS Operation:

In a grid-drive circuit at 890 Mc and bandwidth of 8.5 Mc

DC Plate Voltage	2000	volts
DC Grid-No.2 Voltage	400	volts
DC Grid-No.1 Voltage	-55	volts
DC Plate Current:		
Synchronizing level	350	ma
Pedestal level	260	ma
DC Grid-No.2 Current:		
Synchronizing level	1.3	ma
Pedestal level	1.0	ma
DC Grid-No.1 Current:		
Synchronizing level	0	ma
Pedestal level	0	ma
Driver Power Output:		
Synchronizing level	30	watts
Pedestal level	17	watts
Output Circuit Efficiency	80	%
Useful Power Output:		
Synchronizing level	300	watts
Pedestal level	170	watts

LINEAR RF POWER AMPLIFIER[a]
Single-Sideband Suppressed-Carrier Service

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC PLATE VOLTAGE	2200 max.	volts
DC GRID-No.2 VOLTAGE	400 max.	volts
DC GRID-No.1 VOLTAGE	-100 max.	volts
DC PLATE CURRENT At Peak of Envelope	450[b] max.	ma
DC GRID-No.1 CURRENT	100 max.	ma
GRID-No.2 INPUT	8 max.	watts
PLATE DISSIPATION	400 max.	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance	30,000 max.	ohms
Grid-No.2-Circuit Impedance	See Note **c**	
Plate-Circuit Impedance	See Note **d**	

Typical CCS Operation:

With "Two-Tone" Modulation and at 30 Mc

DC Plate Voltage	2000	volts
DC Grid-No.2 Voltage	400	volts
DC Grid-No.1 Voltage	-44	volts
Zero-Signal DC Plate Current	100	ma
Effective RF Load Resistance	3200	ohms
DC Plate Current at Peak of Envelope	335	ma
Average DC Plate Current	250	ma
DC Grid-No.2 Current at Peak of Envelope	20	ma
Average DC Grid-No.2 Current	13	ma
DC Grid-No.1 Current	0	ma
Peak Envelope Driver Power Output (Approx.)	0.3	watts
Output-Circuit Efficiency (Approx.)	92	%
Distortion Products Level:		
Third Order	30	db
Fifth Order	34	db
Useful Power Output (Approx.):		
Average	205	watts
Peak Envelope	410	watts

FOOTNOTES

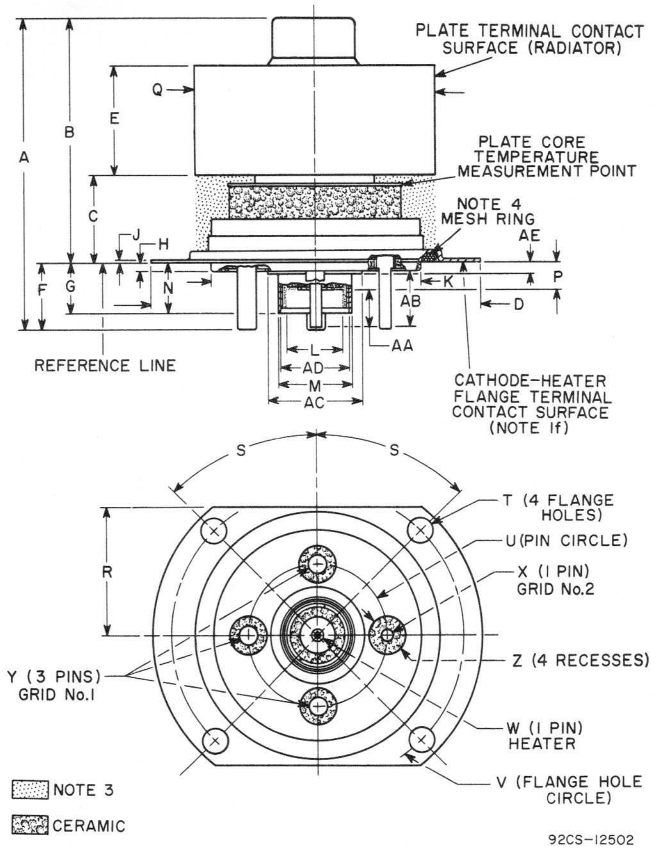
[a] See Section V.C of 1CE-300.

[b] The maximum rating for a signal having a minimum peak-to-average power ratio less than 2, such as is obtained in "Single-Tone" operation, is 300 ma. During short periods of circuit adjustment under "Single-Tone" conditions, the average plate current may be as high as 450 ma.

[c] See Section V.B.2 of 1CE-300.

[d] See Section V.B.1 of 1CE-300.

DIMENSIONAL OUTLINE (Dimensions in Inches)



A - 2.19 max.
B - 1.660 ± 0.060
C - 0.610 ± 0.040
D - 2.262 max. dia.
E - 0.710 min.
F - 0.470 max.
G - 0.355 max.
H - 0.065 max.
J - 0.024 max.
K - 1.435 max. dia. Note 1a
L - 0.400 min. dia.
M - 0.500 ± 0.010 Note 1d
N - 0.300 max.
P - 0.200 max.
Q - 1.625 ± 0.015 dia. Note 1e
R - 0.885 max.
S - 45° ± 5'
T - 0.175 ± 0.005 dia.
U - 0.939 dia.
V - 2.000 dia.
W - 0.081 ± 0.002 dia. Note 2b
X - 0.081 ± 0.002 dia. Note 2c
Y - 0.126 ± 0.002 dia. Note 2a
Z - 0.245 min. dia.
AA - 0.200 min.
AB - 0.325 min.
AC - Note 1b
AD - Note 1c
AE - 0.085 max.

NOTE 1: CONCENTRICITY BETWEEN THE VARIOUS DIAMETERS ON THE MAJOR TUBE AXIS IS SUCH THAT THE TUBE WILL ENTER A GAUGE HAVING SUITABLY SPACED CONCENTRIC APERTURES AND POSTS OF THE FOLLOWING DIAMETERS:

(a) Base seat -- 1.500
(b) Flared flange of cathode-heater cylinder terminal -- 0.680
(c) Cathode-heater cylinder terminal (ID) -- 0.400
(d) Cathode-heater cylinder terminal (OD) -- 0.525
(e) Radiator -- 1.660
(f) Cathode-heater flange terminal contact surface -- 1.760

NOTE 2: CONCENTRICITY OF THE BASE PINS IS SUCH THAT THE TUBE WILL ENTER THE GAUGE IN NOTE 1 HAVING SUITABLY SPACED APERTURES OF THE FOLLOWING DIAMETERS:

(a) Grid-No.1 pins -- 0.1450
(b) Heater pin -- 0.0830 (.123 Dia. x 82° CSK.)
(c) Grid-No.2 pins -- 0.0930

NOTE 3: KEEP ALL STIPPLED REGIONS CLEAR. DO NOT ALLOW CONTACTS OR CIRCUIT COMPONENTS TO PROTRUDE INTO THESE ANNULAR REGIONS.

NOTE 4: RF GASKET, SUCH AS METEX* No.A2733, OR EQUIVALENT.

* Metex Electronics Corp., Walnut Ave., Clark, N.J.

FORCED-AIR COOLING

Air Flow:

Through radiator -- Adequate air flow to limit the plate-core temperature to 250° C should be delivered by a blower through the radiator before and during the application of heater, plate, grid-No.2, and grid-No.1 voltages.

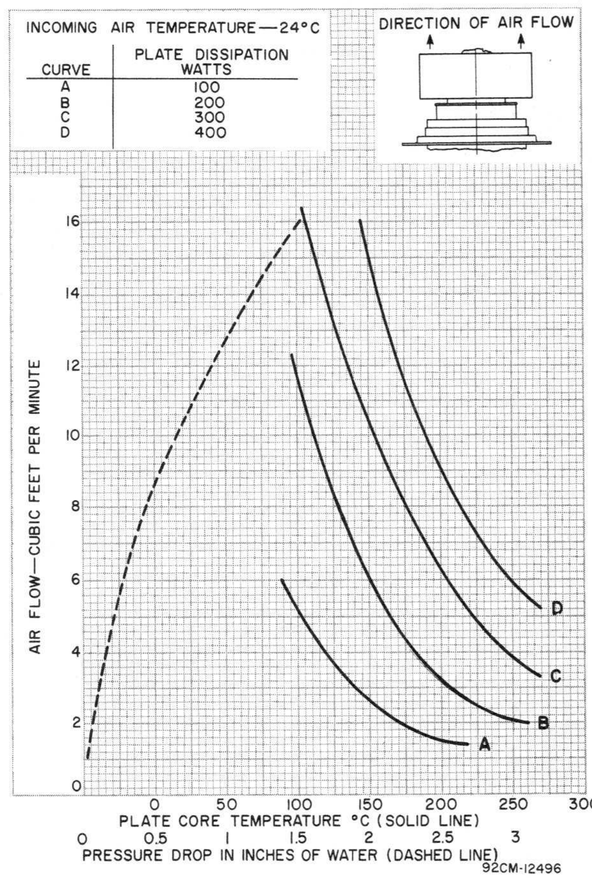
To Plate, Grid-No.2, Grid-No.1, Cathode-Heater and Heater Terminals -- A sufficient quantity of air should be allowed to flow past each of these terminals so that their temperature does not exceed the specified maximum value of 250° C.

During Standby Operation — Cooling air is required when only heater voltage is applied to the tube.

During Shutdown Operation -- Air flow should continue for a few minutes after all electrode power is removed.

For further information on forced-air cooling, see section IV.C of 1CE-300.

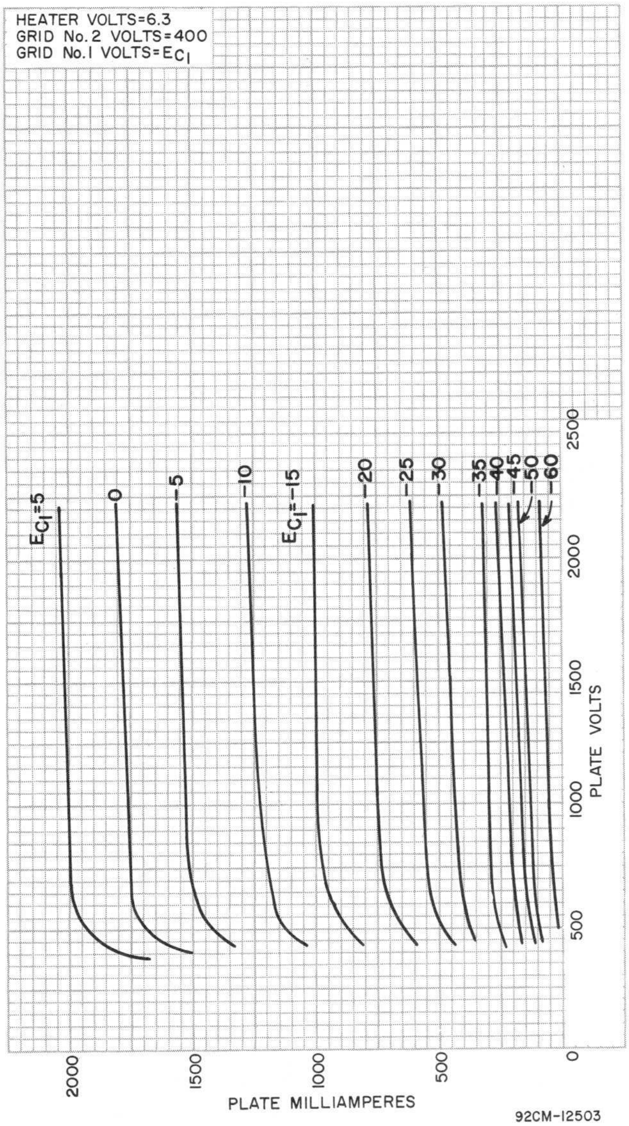
TYPICAL COOLING CHARACTERISTICS



Mounting

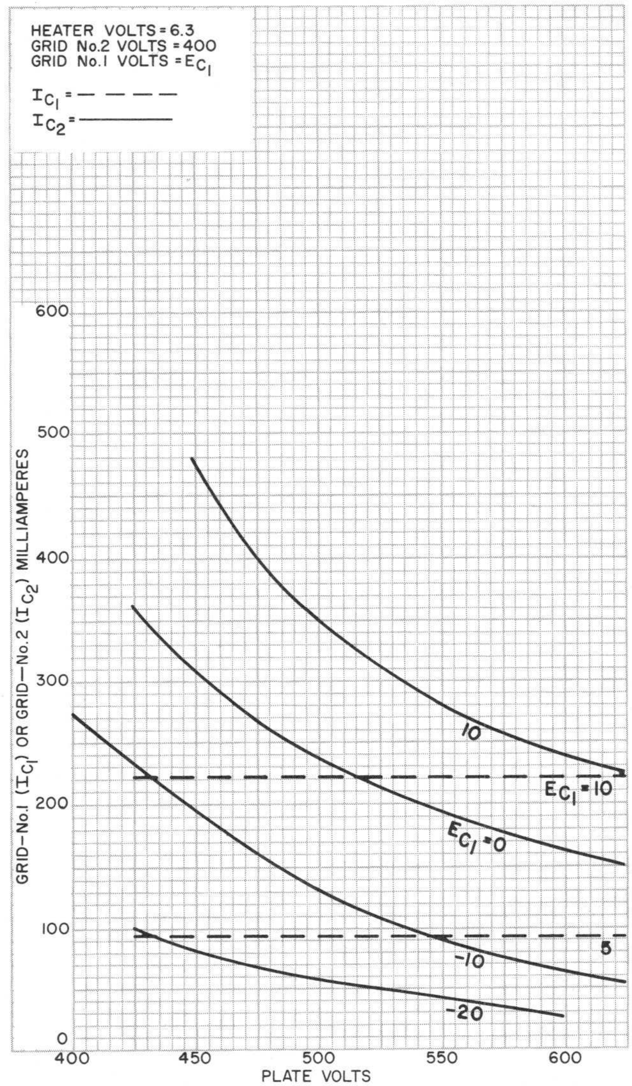
The special base and terminal configuration of the 4624 will require a unique mounting arrangement depending on the frequency use, type of circuit configuration and equipment arrangement. For further information on mounting, see Section III-C of the Applications Guide for RCA Power Tubes, 1CE-300.

TYPICAL PLATE CHARACTERISTICS



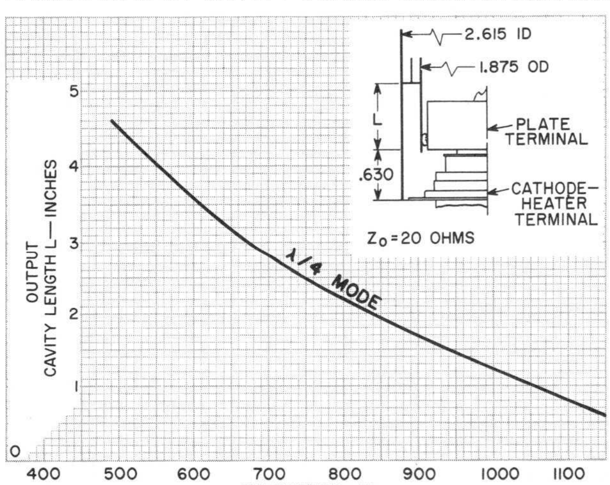
92CM-12503

TYPICAL CHARACTERISTICS



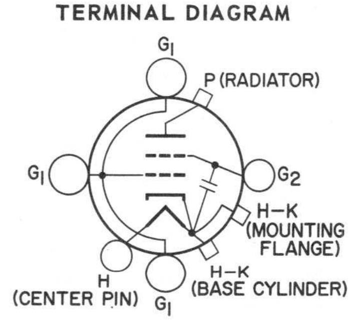
92CM-12504

TYPICAL OUTPUT CAVITY TUNING CHARACTERISTICS



92CS-12501

TERMINAL DIAGRAM



CERMOLOX®

Thoriated-tungsten Mesh Filament

Forced-Air Cooled

10,000 Watts PEP Output at 30 Mc/s

2,000 Watts Carrier Output at 400 Mc/s

Useful to 890 Mc/s

High Gain-Bandwidth Products

RCA-4628

BEAM POWER TUBE

RCA-4628▲ is a forced-air-cooled beam power tube designed especially for use in single sideband service in stationary and portable equipment. It is rated as a linear rf power amplifier in Class AB_1 single sideband suppressed carrier service.

The 4628 and variants of its basic design may also be useful in applications such as af power amplifiers or modulators, plate-modulated rf power amplifiers in Class C telephony service, rf power amplifier and oscillator in Class C telegraphy service, an rf power amplifier in Class C FM telephony service, modulators, pulsed-rf amplifiers, regulators, or other special services. Variations in cooling structure or other parameters are also possible. For information on variants, contact your RCA field representative, or the nearest District Sales Office.

Features of the 4628 include the Cermolox construction, a thoriated-tungsten mesh filament, and an integral louvered-fin radiator. Details of these features are described in the **Application Guide for RCA Power Tubes,** 1CE-300.

▲ Formerly RCA-Dev. No. A2775.

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This bulletin is to be used in conjunction with the publication **Application Guide for RCA Power Tubes,** 1CE-300. For a copy, write RCA, Commercial Engineering, Harrison, N.J.

GENERAL DATA

Electrical:

Filamentary Cathode, Thoriated-Tungsten Mesh Type:		
Voltage[1] (ac or dc)	4.5 to 4.75 typical / 5.0 max.	volts / volts
Current:		
Typical value at 4.5 volts	125	A
Maximum value for starting, even momentarily	300	A
Cold Resistance	0.005	ohm
Minimum heating time	15	s

[1] Measured at tube terminals.

See further information on the filament in **Application Guide for RCA Power Tubes,** 1CE-300; *Section V.A.3,* **Filament or Heater.**

Mu-Factor, Grid No.2 to Grid No.1 for plate volts = 2000, grid-No.2 volts = 1375, and plate amp. = 9.	10	
Direct Interelectrode Capacitances:		
Grid No.1 to plate[a]	0.60 max.	pF
Grid No.1 to filament	60	pF
Plate to filament[ab]	0.11 max.	pF
Grid No.1 to grid No.2	65	pF
Grid No.2 to plate	13	pF
Grid No.2 to filament[b]	3.3 max.	pF

Mechanical:

Operating Position	Vertical, either end up
Overall Length	5.65" max.
Greatest Diameter	6.17" max.
Terminal Connections	*See Dimensional Outline*
Radiator	Integral part of tube
Weight (Approx.)	10 lbs.

Thermal:

Terminal Temperature (Plate, grid No.2, grid No.1, cathode-filament and filament)	250 max.	°C
Plate-Core Temperature	250 max.	°C

See Dimensional Outline for temperature-measurement points

LINEAR RF POWER AMPLIFIER[c]
Single-Sideband Suppressed-Carrier Service

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC PLATE VOLTAGE	7500 max.	volts
DC GRID-No.2 VOLTAGE	1650 max.	volts
DC GRID-No.1 VOLTAGE	-750 max.	volts
DC PLATE CURRENT AT PEAK OF ENVELOPE	4.0 max.	A
DC GRID-No.1 CURRENT	500 max.	mA
GRID-No.2 INPUT[e]	150 max.	watts
PLATE DISSIPATION	10 max.	kW

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Condition:

With fixed bias	5000 max.	ohms
With fixed bias (In Class AB_1 operation)	25,000 max.	ohms
With cathode bias	Not recommended	
Grid-No.2 Circuit Impedance	See Note d	
Plate Circuit Impedance	See Note f	

Typical Class AB_1 CCS Operation with "Two-Tone" Modulation

In a grid-drive circuit, at 30 Mc/s

DC Plate Voltage	7000	volts
DC Grid-No.2 Voltage	1500	volts
DC Grid-No.1 Voltage	-200	volts
Zero-Signal DC Plate Current	0.5	A
Effective RF Load Resistance	1200	ohms
DC Plate Current at Peak of Envelope	3.0	A
Average DC Plate Current	2.15	A
DC Grid-No.2 Current at Peak of Envelope	0.1	A
Average DC Grid-No.2 Current	0.07	A
Peak-Envelope Driver Power Output (Approx.)		Note g
Output Circuit Efficiency (Approx.)	90	%
Useful Power Output (Approx.):		
Average	5000	watts
Peak Envelope	10	kW

LINEAR RF POWER AMPLIFIER[c]
AM Telephony Service

Carrier conditions for use with a maximum modulation factor of 1.0

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC PLATE VOLTAGE	7500 max.	volts
DC GRID-No.2 VOLTAGE	1650 max.	volts
DC GRID-No.1 VOLTAGE	-750 max.	volts
DC PLATE CURRENT	2.0 max.	A
DC GRID-No.1 CURRENT	500 max.	mA
GRID-No.2 INPUT	150 max.	watts
PLATE DISSIPATION	10 max.	kW

Typical Class AB_1 CCS Operation

In a cathode drive circuit, at 400 Mc/s

DC Plate Voltage	6500	volts
DC Grid-No.2 Voltage	1250	volts
DC Grid-No.1 Voltage	-160[h]	volts
DC Plate Current	1.4	A
DC Grid-No.2 Current	0.005	A
Driver Power Output	75	watts
Output Circuit Efficiency (Approx.)	90	%
Useful Power Output	2000	watts

FOOTNOTES

a With external flat metal shield 8" in diameter having a center hole 3" in diameter. Shield is located in plane of the grid-No.2 terminal, perpendicular to the tube axis, and is connected to grid No.2.

b With external flat metal shield 8" in diameter having a center hole 2-3/8" in diameter. Shield is located in plane of the grid-No.1 terminal, perpendicular to the tube axis, and is connected to grid No.1.

c See Section V.C. of 1CE-300.

d See Section V.B.2 of 1CE-300.

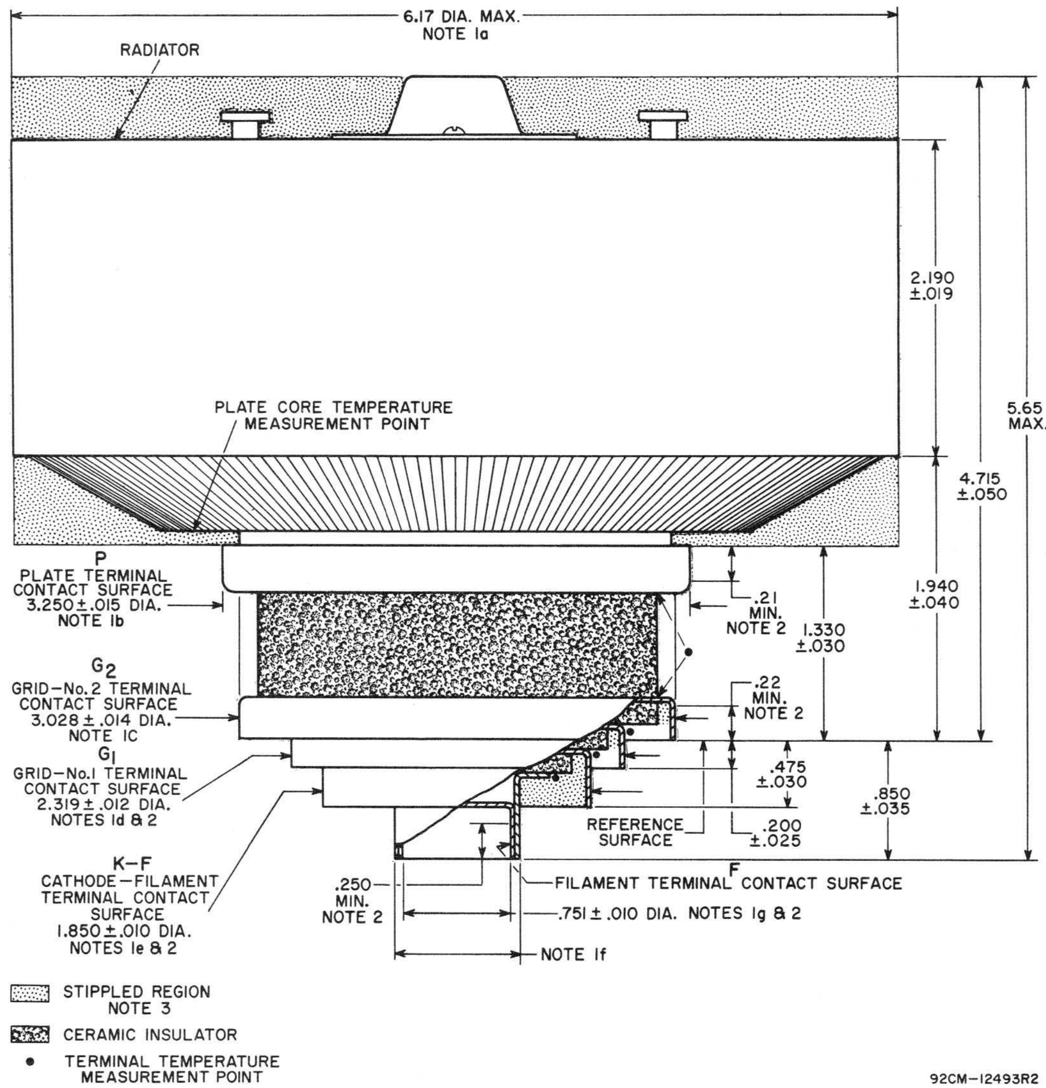
e See Section V.B.3 of 1CE-300.

f See Section V.B.1 of 1CE-300.

g Driver power output represents circuit losses and is the actual power measured at input to grid-No.1 circuit. The actual power required depends on the operating frequency and the circuit used. The tube driving power is approximately zero watts.

h Typical value for 1 ampere of DC plate current with carrier turned off.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

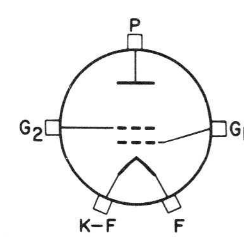
NOTE 1: CONCENTRICITY BETWEEN THE VARIOUS DIAMETERS IS SUCH THAT THE TUBE WILL ENTER A GAUGE HAVING SUITABLY SPACED CONCENTRIC APERTURES AND POSTS OF THE FOLLOWING DIAMETERS:

a. Radiator - 6.241
b. Plate Terminal - 3.288
c. Grid-No.2 Terminal - 3.061
d. Grid-No.1 Terminal - 2.338
e. Cathode-Filament Terminal - 1.878
f. Filament Terminal (OD) - 0.908
g. Filament Terminal (ID) - 0.722

NOTE 2: THE DIAMETER OF THE TERMINAL IS HELD TO THE INDICATED VALUE ONLY OVER THE CONTACT SURFACE LENGTH. THE CONTACT SURFACE LENGTH OF THE CATHODE-FILAMENT AND GRID-No.1 TERMINALS EXTENDS FROM THE EDGE OF ITS TERMINAL TO THE PLANE COINCIDENT WITH THE EDGE OF THE ADJACENT LARGER TERMINAL.

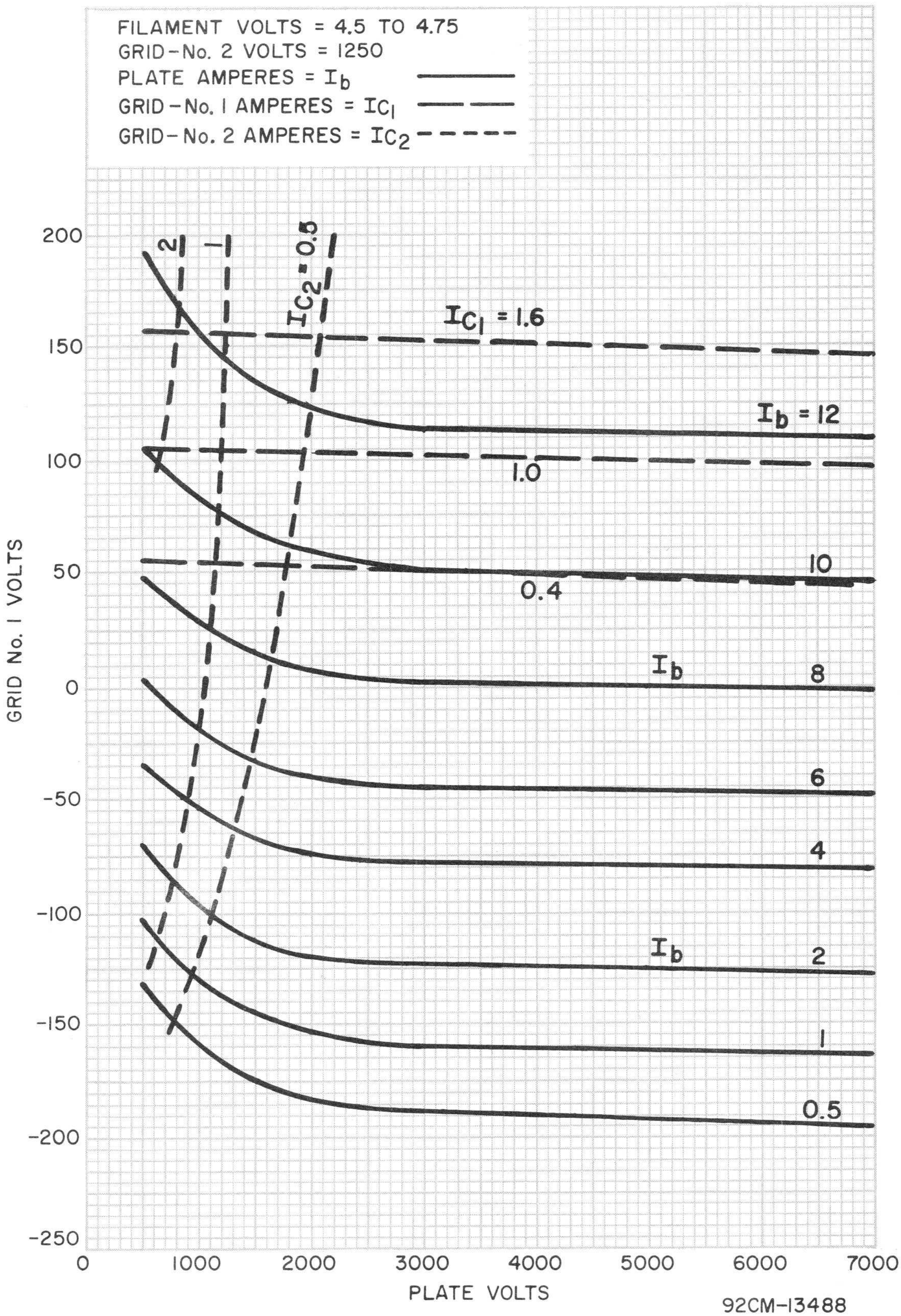
NOTE 3: KEEP ALL STIPPLED REGIONS CLEAR. DO NOT ALLOW CONTACTS OR CIRCUIT COMPONENTS TO PROTRUDE INTO THESE ANNULAR REGIONS.

TERMINAL DIAGRAM



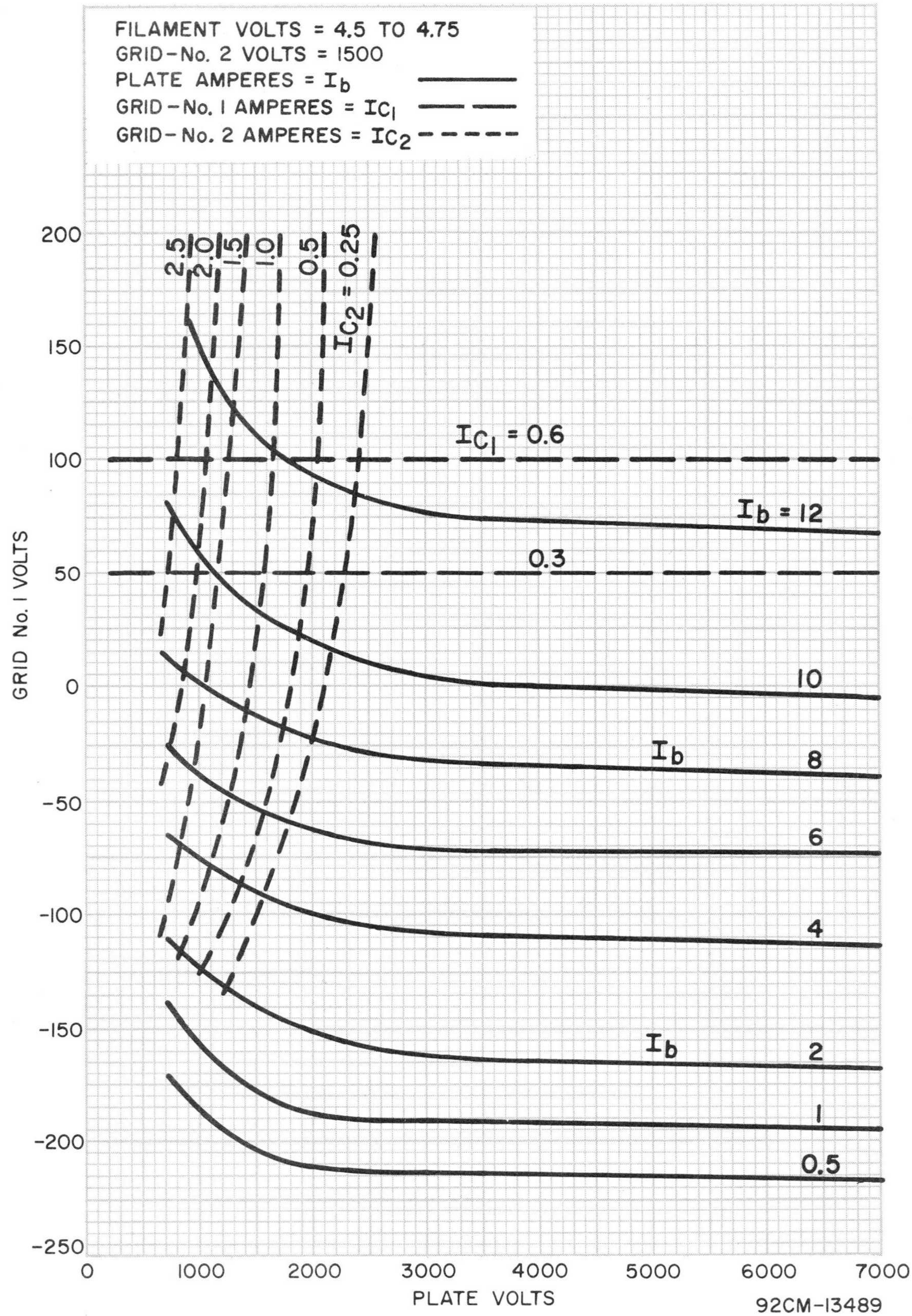
TYPICAL CONSTANT-CURRENT CHARACTERISTICS

For Grid-No. 2 Voltage =1250 Volts

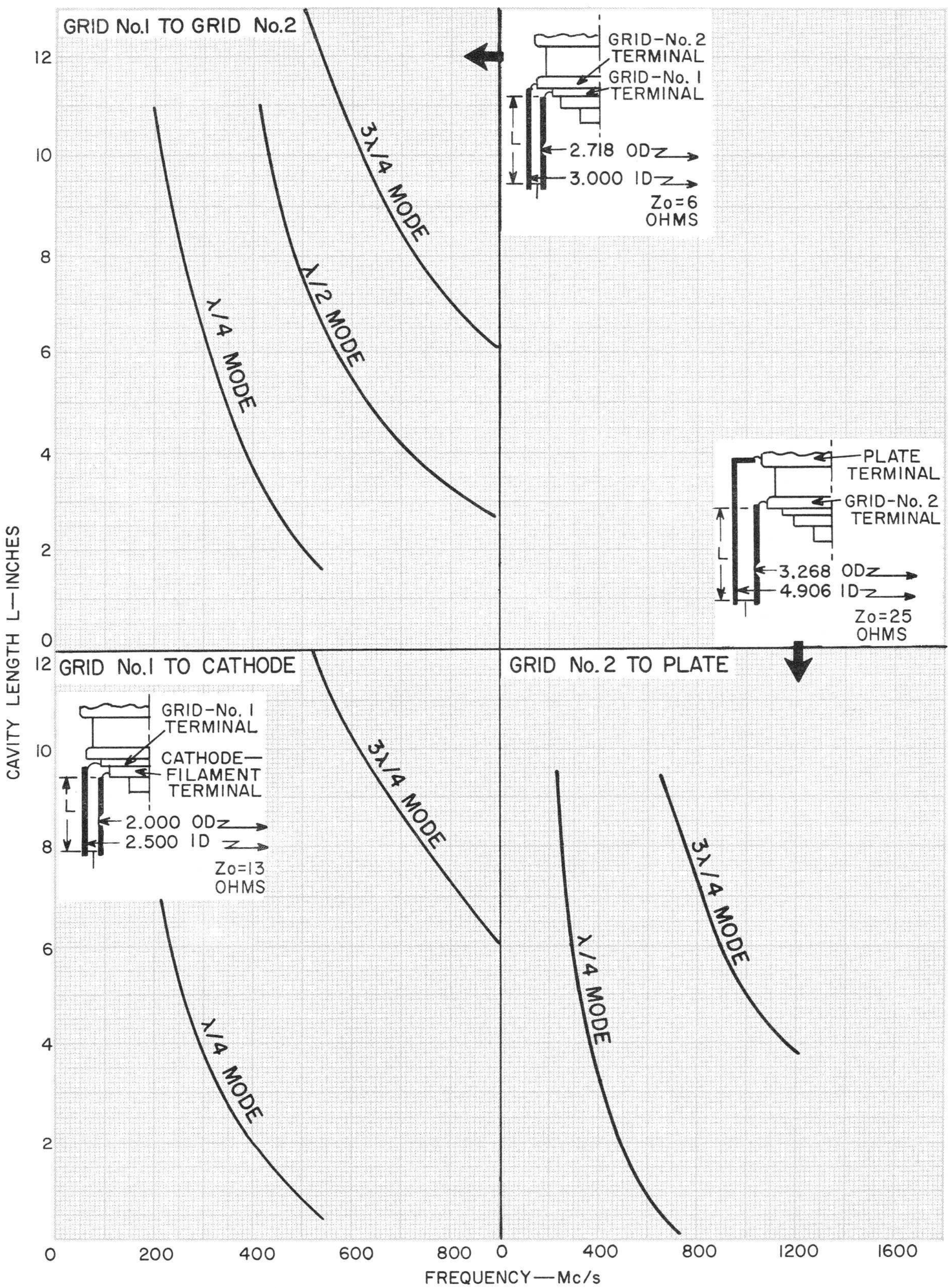


TYPICAL CONSTANT-CURRENT CHARACTERISTICS

For Grid-No.2 Voltage =1500 Volts



CAVITY TUNING CHARACTERISTICS



92CM-12492R2

FORCED-AIR COOLING

Air Flow:

Through radiator -- Adequate air flow to limit the plate-core temperature to 250° C should be delivered by a blower through the radiator before and during the application of filament, plate, grid-No.2, and grid-No.1 voltages.

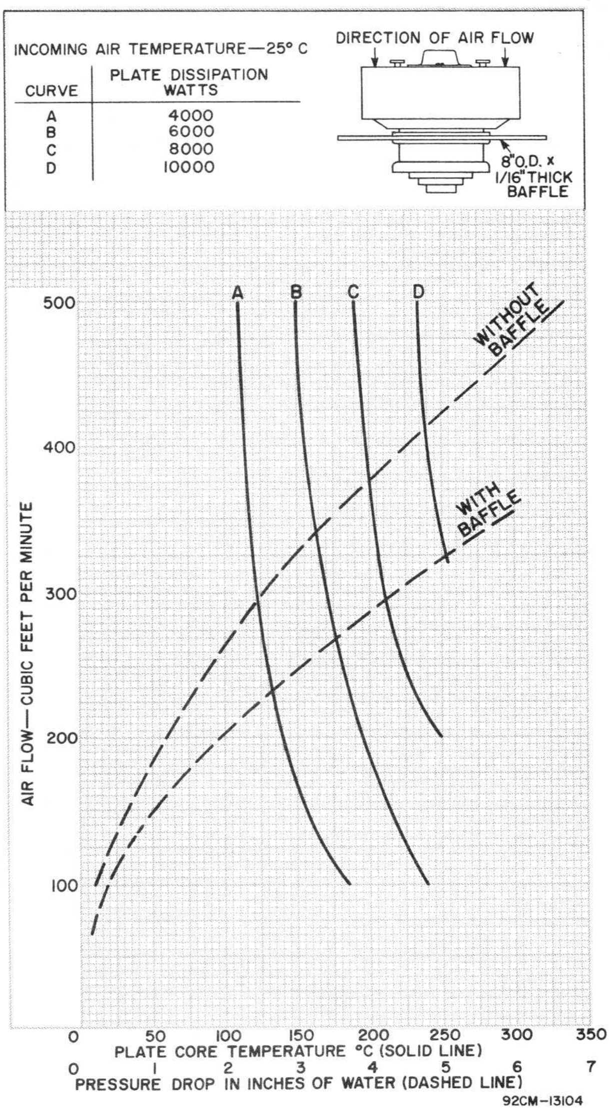
To Plate, Grid-No.2, Grid-No.1, Cathode-Filament, and Filament Terminals -- A sufficient quantity of air should be allowed to flow past each of these terminals so that their temperature does not exceed the specified maximum value of 250° C.

During Standby Operation -- Cooling air is required when only filament voltage is applied to the tube.

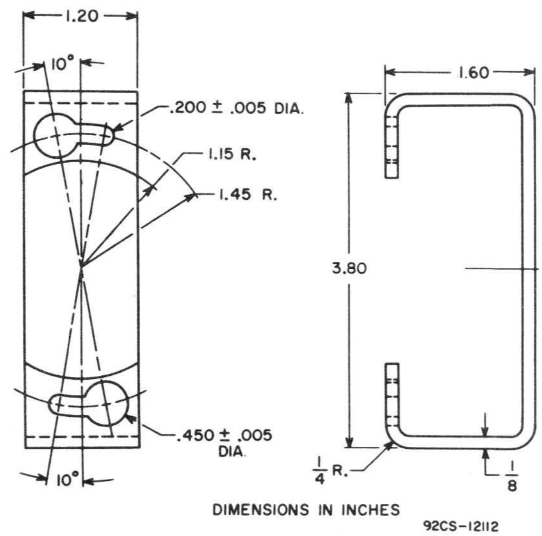
During Shutdown Operation -- Air flow should continue for a few minutes after all electrode power is removed.

For further information on forced-air cooling, see section IV.C of 1CE-300.

TYPICAL COOLING CHARACTERISTICS



TUBE EXTRACTOR (Suggested Design)

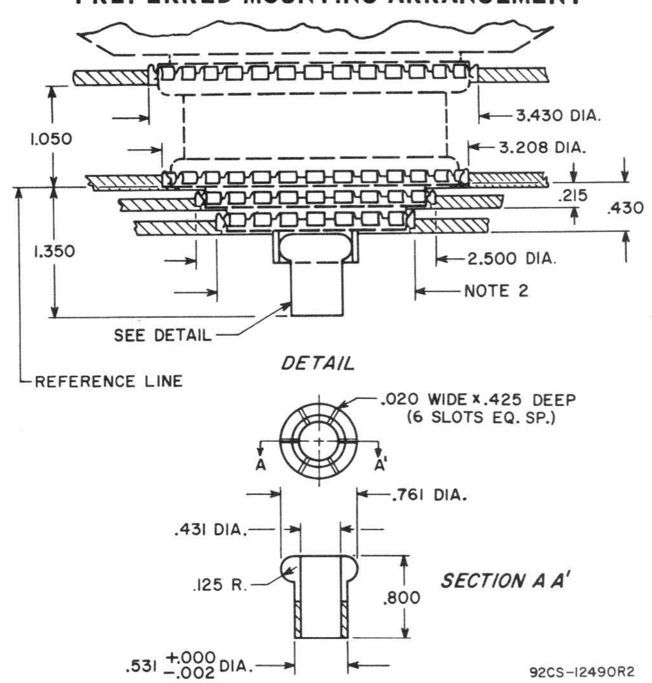


NOTE 1: MATERIAL 1/8" THICK COLD ROLLED STEEL.
NOTE 2: SLOT BETWEEN HOLES.
NOTE 3: ROUND ALL EDGES.

Mounting

See the preferred mounting arrangement below. For other arrangements, cavity-type mounting for multiple-ring terminal-type tubes, such as the 4628 may be constructed by using either fixed or adjustable contact rings of finger contact strips in the transverse plane as described in section III.C.3 of 1CE-300.

PREFERRED MOUNTING ARRANGEMENT



DIMENSIONS IN INCHES

NOTE 1: FINGER STOCK IS NO. 97-360 MADE BY INSTRUMENT SPECIALTIES CO., LITTLE FALLS, N.J.

NOTE 2: CATHODE RING DIA. IS 2.030" WHEN USING NO. 97-360 FINGER STOCK OR 2.080" WHEN USING NO. 97-135 FINGER STOCK. MADE BY INSTRUMENT SPECIALTIES CO., LITTLE FALLS, N.J.

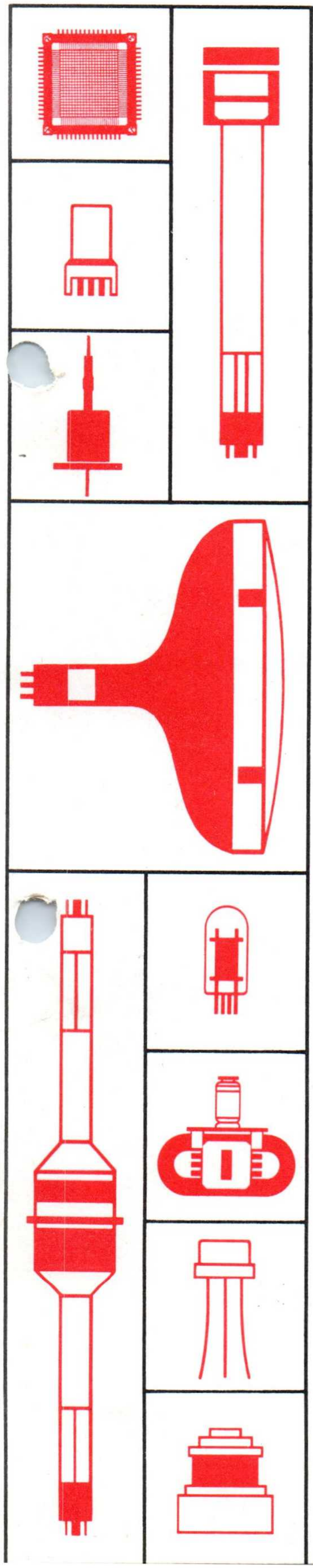
RCA

NEW PRODUCT ANNOUNCEMENT

RADIO CORPORATION OF AMERICA

INTERNATIONAL DIVISION / HARRISON, N. J.

LICENSEE SERVICE



RCA-4632

NEW UHF CERMOLOX TUBE

RCA-4632 joins the "8501 family" as a smaller-radiator, matrix-cathode version of this family of beam power tubes with precision-aligned grids, ceramic-metal construction, and coaxial-electrode-and-terminal structure.

APPLICATIONS: RF Power Amplifier and Oscillator

CAPABILITY: 2300 Watts CW Output at 890 MHz

ADVANTAGES: Simplified Forced-Air Cooling
Now-Famous Cermolox Construction

ADDITIONAL INFORMATION: A bulletin giving detailed technical information on the 4632 is attached for your convenience.

October 20, 1966

CERMOLOX®

Matrix-Type Cathode

Forced-Air Cooled

2300 Watts CW Output at 890 MHz

Useful to 900 MHz

High Gain-Bandwidth Products

RCA-4632

BEAM POWER TUBE

RCA-4632▲ is a forced-air-cooled beam power tube designed for use in stationary and portable equipment. It is rated as an rf power amplifier and oscillator in Class B or Class C telegraphy or Class C FM telephony service.

The 4632 and variants of its basic design may also be useful in applications such as af power amplifiers or modulators, plate-modulated rf power amplifiers in Class C telephony service, hard-tube modulators, pulsed-rf amplifiers, regulators, or other special services. Variations in cooling structure or other parameters are also possible. For information on variants, contact your RCA field representative, or the nearest District Sales Office.

Features of the 4632 include the Cermolox construction, matrix-type oxide coated cathode, and an integral louvered-fin radiator. Details of these features are described in the **Application Guide for RCA Power Tubes, 1CE-300.**

▲*Formerly RCA-Dev. No.A2841*

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●This bulletin is to be used in conjunction with the publication **Application Guide for RCA Power Tubes, 1CE-300.** For a copy, write RCA, Commercial Engineering, Harrison, N.J.

GENERAL DATA

Electrical:

Heater, for Matrix-Type Oxide-Coated Unipotential Cathode:

Voltage[1] (AC or DC)	5.5 typical volts
Current:	
Typical value at 5.5 volts	31 A
Minimum heating time	3 min.

See further information on the heater in **Application Guide for RCA Power Tubes,** *1CE-300; Section V.A.3,* **Filament or Heater.**

Mu-Factor, Grid No.2 to Grid No.1 for plate volts = 5000 grid-No.2 volts = 900 and plate amperes = 1.0 . . . 14

Direct Interelectrode Capacitances:

Grid No.1 to plate[a]	15	max.	pF
Grid No.1 to heater	60		pF
Plate to heater[ab]	0.024	max.	pF
Grid No.1 to grid No.2	60		pF
Grid No.2 to plate	12		pF
Grid No.2 to heater[b]	1.2	max.	pF

Mechanical:

Operating Position	Any
Overall Length	4.70" max.
Greatest Diameter	4.570" max.
Terminal Connections	See *Dimensional Outline*
Radiator	Integral part of tube
Weight (Approx.)	6 lbs.

Thermal:

Terminal Temperature (Plate, grid No.2, grid No.1, cathode-heater and heater)	250	max.	°C
Plate-Core Temperature	250	max.	°C

See Dimensional Outline for temperature-measurement points

[1]Measured at tube terminals. The cathode may be subjected to RF heating as the frequency of operation is increased. It is recommended that the heater voltage be operated at the lowest voltage that will give stable performance.

RF POWER AMPLIFIER & OSCILLATOR – Class C Telegraphy[c]
and
RF POWER AMPLIFIER – Class C FM Telephony[c]

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC PLATE VOLTAGE[f]	7000 max.	volts
DC GRID-No.2 VOLTAGE[d]	1500 max.	volts
DC GRID-No.1 VOLTAGE	–250 max.	volts
DC PLATE CURRENT	3 max.	A
DC GRID-No.1 CURRENT	0.5 max.	A
GRID-No.1 INPUT[e]	50 max.	watts
GRID-No.2 INPUT[d]	75 max.	watts
PLATE DISSIPATION	5000 max.	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance	5000 max.	ohms
Grid-No.2-Circuit Impedance	See Note **d**	
Plate-Circuit Impedance	See Note **f**	

Typical CCS Operation:

In a cathode-drive circuit at 890 MHz and bandwidth of 8.5 MHz

DC Plate Voltage	3700	volts
DC Grid-No.2 Voltage	800	volts
DC Grid-No.1 Voltage	–55	volts
DC Plate Current	2.0	A
DC Grid-No.2 Current	–.020	A
DC Grid-No.1 Current	0	A
Driver Power Output[g]	200	watts
Output-Circuit Efficiency (Approx.)	80	%
Useful Power Output	2300	watts

FOOTNOTES

[a]With external flat metal shield 8" in diameter having a center hole 3" in diameter. Shield is located in plane of the grid-No.2 terminal, perpendicular to the tube axis, and is connected to grid No.2.

[b]With external flat metal shield 8" in diameter having a center hole 2-3/8" in diameter. Shield is located in plane of the grid-No.1 terminal, perpendicular to the tube axis, and is connected to grid No.1.

[c]See Section V.C. of 1CE-300.

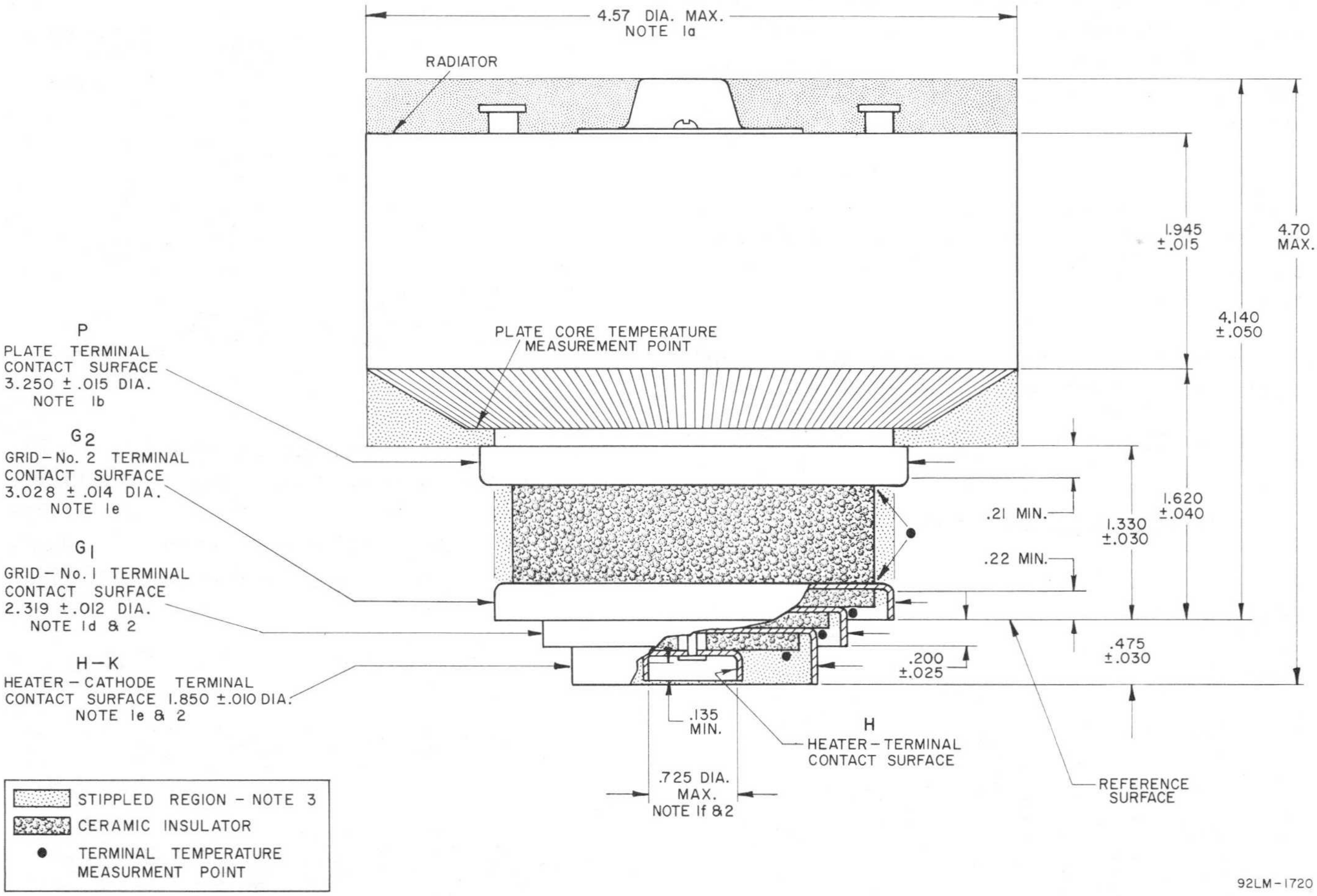
[d]See Section V.B.2 of 1CE-300. A spark gap must be used to prevent the build-up of excessive grid-No.2 voltage transients and a minimum series impedance of 100 ohms must be used in the grid-No.2 lead to limit momentary fault currents. A bleeder current of at least 1/10 the required plate current is also required.

[e]See Section V.B.3 of 1CE-300.

[f]See Section V.B. and V.B.1 of 1CE-300. A series impedance of 100 ohms is required in the plate lead to limit momentary fault currents.

[g]Driver power output includes circuit losses and is the actual power measured at input to grid-No.1 circuit. The actual power required depends on the operating frequency and the circuit used.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

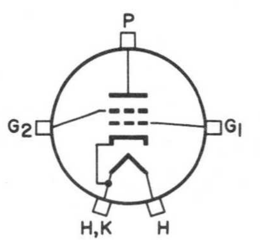
NOTE 1: Concentricity between the various diameters is such that the tube will enter a gauge having suitably spaced concentric apertures and posts of the following diameters:

a. Radiator – 4.67
b. Plate Terminal – 3.288
c. Grid-No.2 Terminal – 3.061
d. Grid-No.1 Terminal – 2.338
e. Heater-Cathode Terminal – 1.878
f. Heater Terminal (ID) – .6950

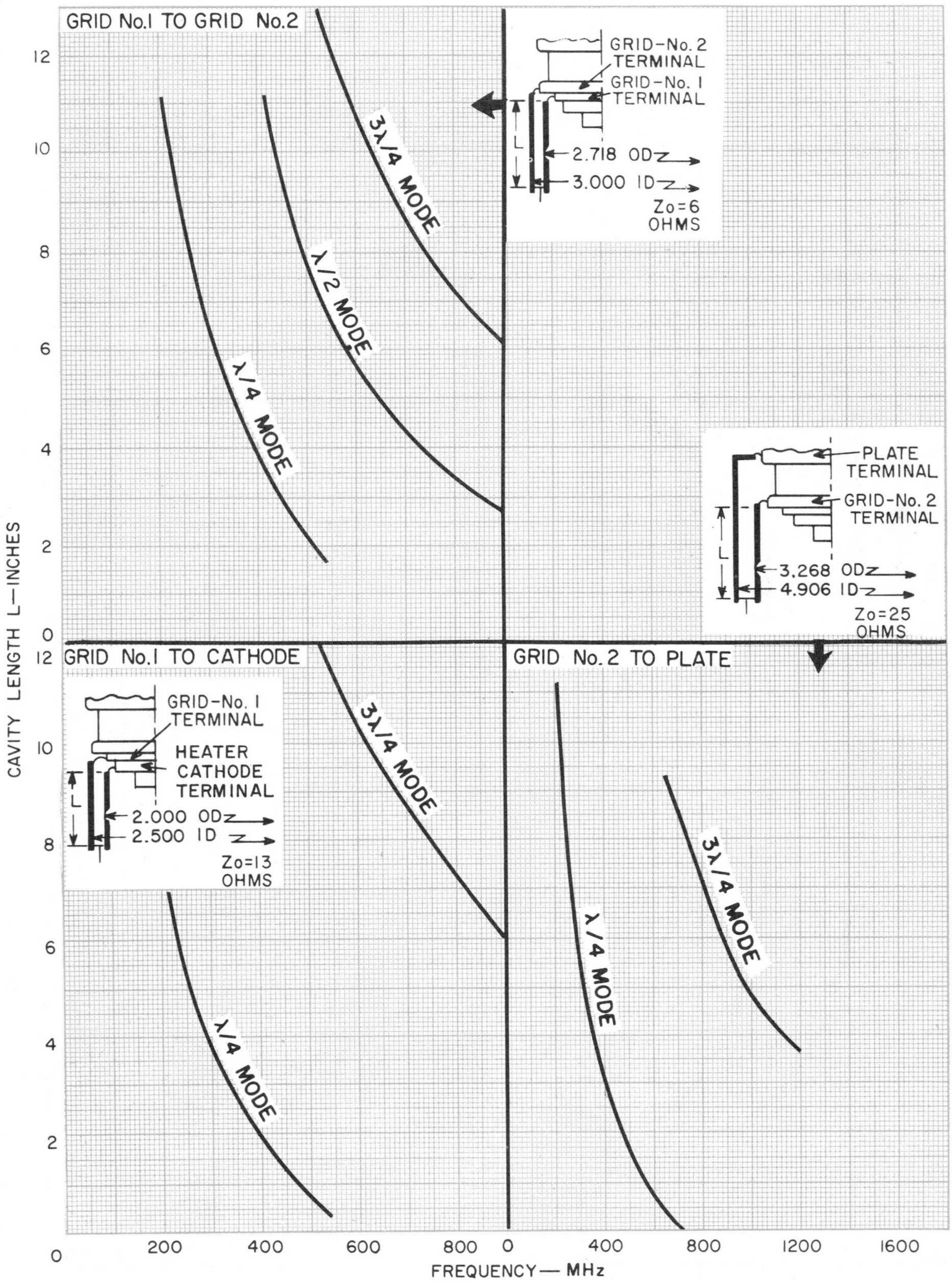
NOTE 2: The diameter of the terminal is held to the indicated value only over the contact surface length. The contact surface length of the Heater-Cathode and Grid-No.1 terminals extends from the edge of its terminal to the plane coincident with the edge of the adjacent larger terminal.

NOTE 3: Keep all stippled regions clear. Do not allow contacts or circuit components to protrude into these annular regions.

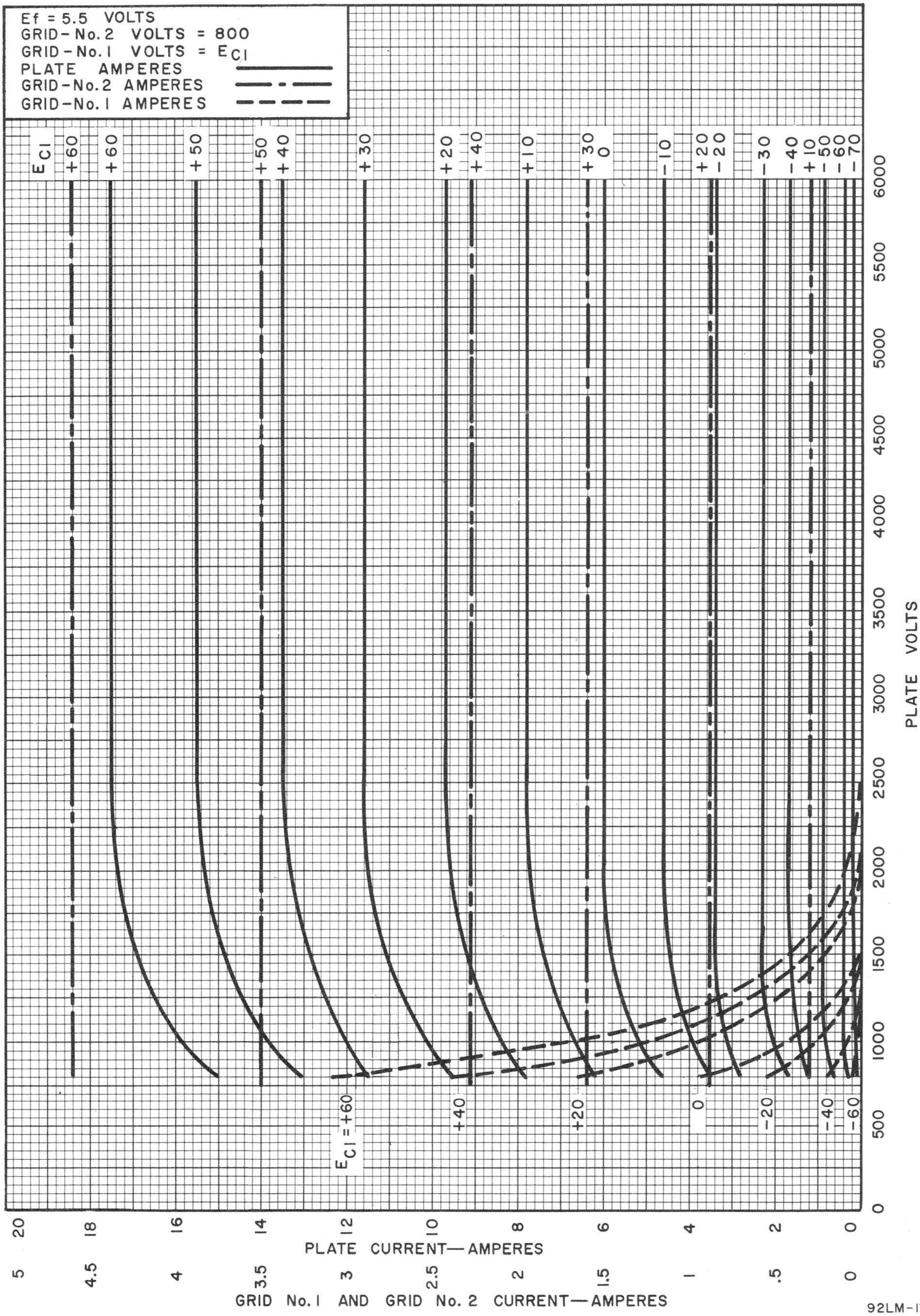
TERMINAL DIAGRAM



CAVITY TUNING CHARACTERISTICS



TYPICAL CHARACTERISTICS



92LM-1721

FORCED-AIR COOLING

Air Flow:

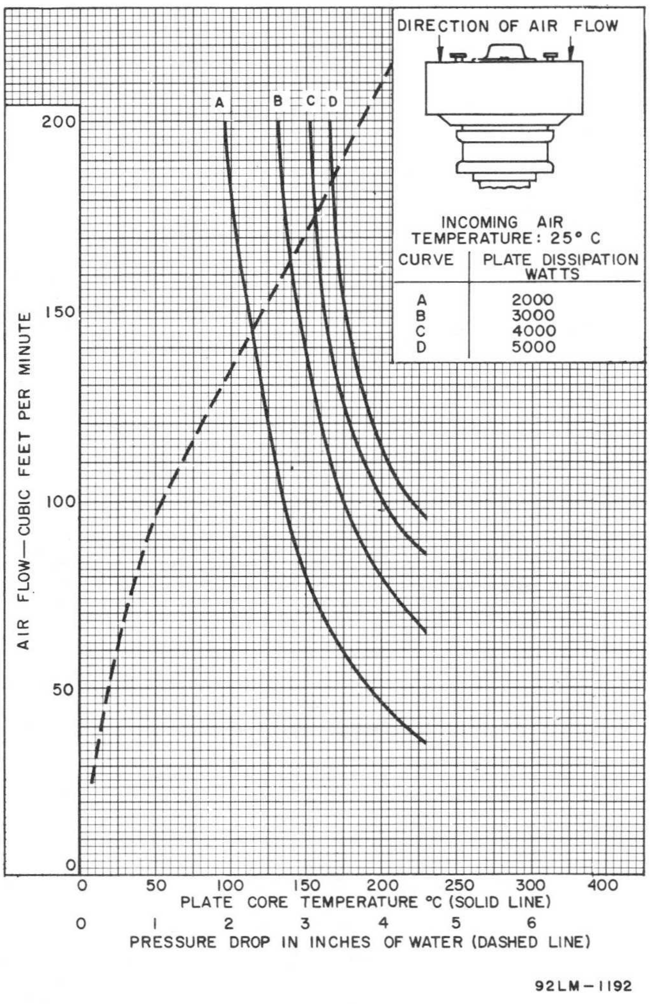
Through radiator – Adequate air flow to limit the plate-core temperature to 250° C should be delivered by a blower through the radiator before and during the application of heater, plate, grid-No.2, and grid-No.1 voltages.

To Plate, Grid-No.2, Grid-No.1, Heater-Cathode and Heater Terminals – A sufficient quantity of air should be allowed to flow past each of these terminals so that their temperature does not exceed the specified maximum value of 250° C.

During Standby Operation – Cooling air is required when only heater voltage is applied to the tube.

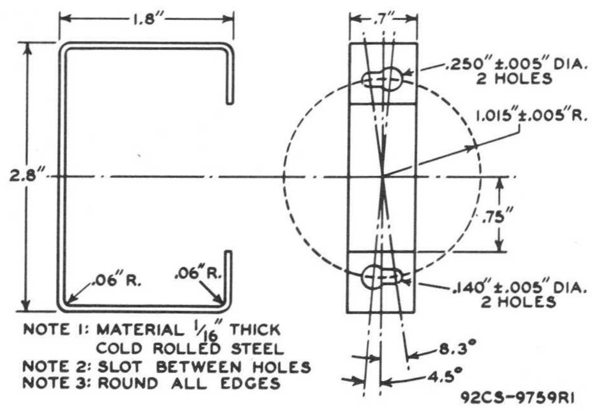
During Shutdown Operation – Air flow should continue for a few minutes after all electrode power is removed.

TYPICAL COOLING CHARACTERISTICS



TUBE EXTRACTOR

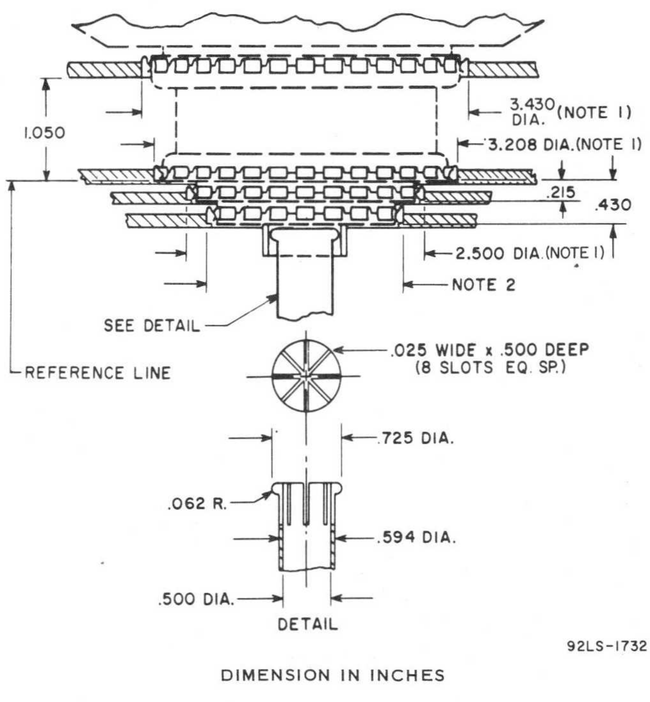
Suggested Design



Mounting

See the preferred mounting arrangement below. For other arrangements, cavity-type mounting for multiple-ring terminal-type tubes, such as the 4632, may be constructed by using either fixed or adjustable contact rings of finger contact strips in the transverse plane as described in section III.C.3 of 1CE-300.

PREFERRED MOUNTING ARRANGEMENT



DIMENSION IN INCHES

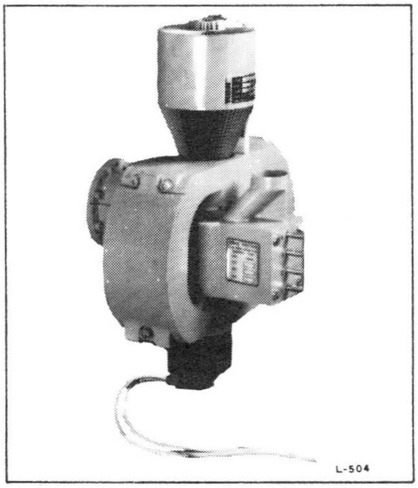
NOTE 1: Finger Stock is No.97-360 made by Instrument Specialties Co., Little Falls, N.J.

NOTE 2: Cathode Ring dia. is 2.030" when using No.97-360 Finger Stock or 2.080" when using No.97-135 Finger Stock. Made by Instrument Specialties Co., Little Falls, N.J.

RCA
Electronic Components

Klystron

4658/VA888D


L-504

C Band Klystron

- Gang Tuned Cavities
- Air Cooled
- High Efficiency
- High Power Gain
- Compact
- Sturdy

The RCA 4658/VA888D is a permanent magnet focused, gang-tuned, four-cavity klystron designed to deliver more than one kilowatt of CW output power at C Band for communication and radar applications.

This klystron is ideal for applications such as tropospheric forward scatter communications because of its light weight, air cooling, and permanent-magnet focusing. It operates at high efficiency and high power gain over the entire tunable range from 4.4 to 5.0 GHz. These characteristics permit the use of small power supplies andl low power RF drivers to obtain minimum system size, weight, and cost.

This bulletin gives information describing the RCA 4658/VA888D. Supplementary application information covering handling, installation and operation, may be obtained through your RCA Field Representative, or write Super Power Tube Marketing, Lancaster, PA 17604.

General Data

Frequency .... 4.4 to 5.0 GHz

Electrical:

Cathode .... Indirectly-heated Tungsten Dispenser Cathode

Filament:

Voltage	6.5 ± 0.5	V
Current at 6.5 V	7.6	A
Maximum current	8.2	A
Warmup time (min.)	180	s

Mechanical:

Mounting Position		Any	
Length (max.)	(393 mm)	15.5	in
Width (max.)	(267 mm)	10.5	in
Weight (approx.)	(17.2 kg)	38	lb
In commercial pack	(18.1 kg)	40	lb
In military pack	(22.5 kg)	50	lb

Thermal:

Collector Temperature (max.)	260	°C
Body Temperature (max.)	150	°C
Tuner Fin Temperature (max.)	150	°C
Electron Gun Potting		
Insulation temperature (max.)	250	°C
Storage temperature (min.)	-65	°C

Cooling

Forced air flow across the collector, body, and tuner, is required.

Typical air requirements for operation with 20° C ambient air temperature at sea level are:

	Min Req Air Flow lb/min	kg/min	Max Press-Drop in H_2O	cm H_2O
Collector	7.5	3.4	2.0	5.1
Body & Tuners	0.85	0.38	0.75	1.9

Performance

Maximum CW Ratings, Absolute-Maximum Values:

DC Beam Voltage	8.5	kV
DC Beam Current	600	mA
DC Body Current	60	mA
Surge Current	25	A
Load VSWR	2.0:1	
Input VSWR	2.0:1	

Typical CW Operation:

High Efficiency Tuned

Frequency	**4.4 GHz**	**5.0 GHz**	
DC Beam Voltage	7.5	7.5	kV
DC Beam Current	490	490	mA

Typical CW Operation (cont'd.)

High Efficiency Tuned

Frequency	4.4 GHz	5.0 GHz	
DC Body Current	10.0	10.0	mA
RF Power Output	1.45	1.30	kW
Bandwidth (3 dB)	8.0	10.0	MHz
Efficiency	39.0	35.0	%
Gain	44.0	44.0	dB
Drive	50.0	50.0	mW
Load VSWR	1.05:1	1.05:1	–
Input VSWR	1.3:1	1.3:1	–

High Gain Tuned

Frequency	4.4 GHz	5.0 GHz	
DC Beam Voltage	7.5	7.5	kV
DC Beam Current	490	490	mA
DC Body Current	10.0	10.0	mA
RF Power Output	1.30	1.15	kW
Bandwidth (3 dB)	6.0	8.0	MHz
Efficiency	35.0	31.0	%
Gain	51.0	51.0	dB
Drive	10.0	10.0	mW
Load VSWR	1.05:1	1.05:1	–
Input VSWR	1.3:1	1.3:1	–

Broadband Tuned

Frequency	4.4 GHz	5.0 GHz	
DC Beam Voltage	7.5	7.5	kV
DC Beam Current	490	490	mA
DC Body Current	10.0	10.0	mA
RF Power Output	1.35	1.25	kW
Bandwidth (3 dB)	13.0	19.0	MHz
Efficiency	36.0	33.0	%
Gain	41.0	41.0	dB
Drive	100.0	100.0	mW
Load VSWR	1.05:1	1.05:1	–
Input VSWR	1.3:1	1.3:1	–

General Information

Installation and Operation

No installation or operation should be attempted without first consulting the Installation and Operating Instructions shipped with each tube or available on request from Super Power Marketing, RCA, Lancaster, PA.

RCA reference publications required for the installation and operation of this device include the following:

Data Sheet – RCA-4658/VA888D
Application Note AN 4213
Application Guide 1CE-279A

These publications are available as a complete packet – request PWR 543 "Applications Information for the RCA-4658/VA888D klystron."

Personnel Safety

The high voltages and microwave radiations from this device can be dangerous to life. High voltage shielding and interlock precautions must be taken and all rf connections must be tightly closed and rf terminals shielded.

Packaging

Two types of packaging are available with these tubes; Commercial Pack and Military Pack. The customer specifies the desired type.

The Commercial Pack is made of nesting carboard cartons with the inner carton shock-mounted. The Military Pack complies with MIL-S-4473C for air shipment. It uses a hermetically-sealed metal container which protects the tube and serves to shield the area surrounding the pack from stray magnetic fields set up by the klystron focusing magnet.

In shipment, the tube is enclosed in a polyethylene bag to prevent dust and other particles from collecting in the waveguide or tuning system. It is recommended that the tube be stored in the bag and in the shipping container when not in use. Dust or other unwanted particles in the waveguide can cause arcing during operation and subsequent tube destruction.

Cooling

Air ducts must be provided to connect to the top of the collector and the tuner cooling duct. See Outline Drawing.

Mounting

Four holes are provided in the gun-end of the focusing magnet for mounting purposes. Only non-magnetic studs should be used.

Thermocouple

A thermocouple mounted on the collector provides a signal output for excessive collector temperature. This output is used to operate protective circuitry.

Tuning

Tuning is accomplished by a single knob which "gang-tunes" all four cavities simultaneously. The second, third and output cavities may be individually trimmed for optimizing the tube performance at any frequency within the tube operating band. See Outline Drawing.

Protection Circuits

Protection circuits serve a threefold purpose: safety of personnel, protection of the tube and protection of tube circuits. Consult Application Guide 1CE-279A for complete information on protection circuits.

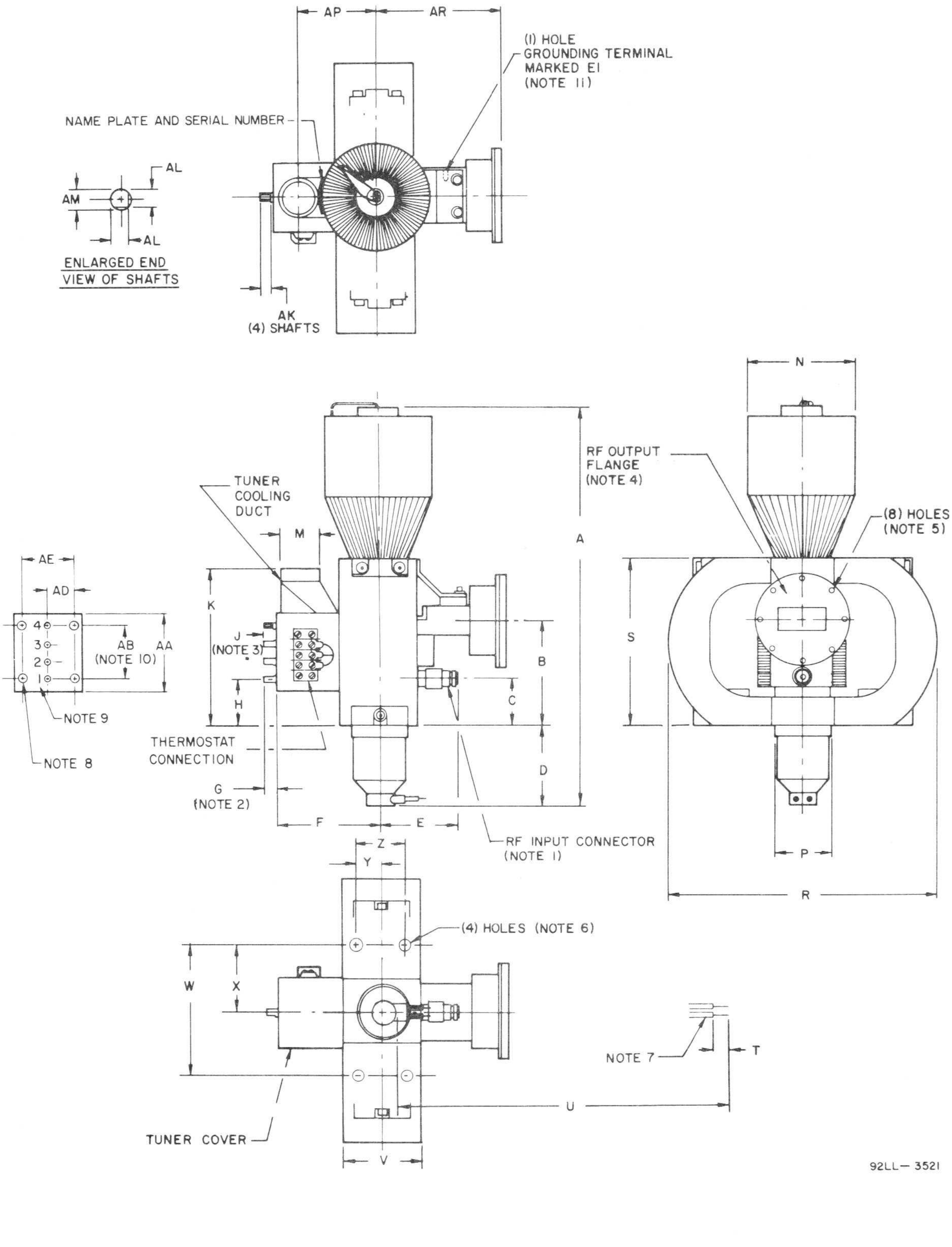


Figure 1 — Outline Drawing

Tabulated Dimensions* for the Outline Drawing

Dimension Reference	Specified Values Inches	Millimeters
A	15.5 max.	393.7 max.
B	4.06 ±.12	103.1 ±3.0
C	1.80 ±.12	45.7 ±3.0
D	3.5 max.	88.9 max.
E	3.00 ±.06	76.2 ±1.5
F	3.80 ±.12	96.5 ±3.0
G	0.68 ±.05	17.3 ±1.3
H	1.80 ± .09	45.7 ±2.3
J	0.68 +.15 -.10	17.3 +3.8 -2.5
K	6.25 max.	158.8 max.
M	1.50 ±.03	38.1 ± .8
N Dia.	4.12 ±.03	101.6 ± .8
P Dia.	2.130 ±.015	54.10 ± .38
R	10.5 max.	266.7 max.
S	6.5 ±.5	165.0 ±13.0
T	0.50 ±.12	12.7 ± 3.0
U	15.00 ±.25	381.0 ± 6.0
V	3.25 max.	82.55 max.
W	5.00 ±.06	127.0 ±1.5
X	2.50 ±.06	63.5 ±1.5
Y	1.00 ±.06	25.4 ±1.5
Z	2.00 ±.06	50.8 ±1.5
AA	3.00 ±.06	76.2 ±1.5
AB	2.10 ±.02	53.34 ± .51
AD	1.00 ±.03	25.4 ± .8
AE	2.00 ±.03	50.8 ± .8
AK	0.440 ±.010	11.18 ±.25
AL	0.230 ±.005	5.84 ±.13
AM Dia.	0.249 ±.002	6.325 ±.051
AP	3.00 ±.06	76.2 ±1.5
AR	4.75 ±.12	120.6 ±3.0

Notes for Outline Drawing

1. Mates with Type "N" Connector UG-21 B/U or equivalent.
2. Dimension applies to Shaft No.1 only.
3. Dimension applies to Shafts No,'s 2, 3, and 4 only.
4. Mates with UG-149 A/U or equivalent.
5. Holes 10-32 UNF-2B equally spaced on 3.250" ± .032" (82.6 ± .8 mm) dia. circle.
6. Holes 0.437" ± .062" (11.1 ± 1.6 mm) thru (One side only).
7. High-Voltage Lead Designation
   Heater Lead – Yellow
   Heater-Cathode Lead – White
8. Thru-holes checked with gauge.
9. Three spaces between shafts are 0.70" ± .03" (17.8 ± .8 mm) and add to 2.100" (53.34 mm). Shafts are numbered as shown.
10. Tolerance for this dimension applies to location of four 0.201" (5.11 mm) holes.
11. Hole #6-32 UNC-2B, 0.25" (6.35 mm) minimum depth.

*Basic dimensions are in inches unless otherwise stated. Metric equivalents are derived from the basic inch dimensions (One inch = 25.4 millimeters).

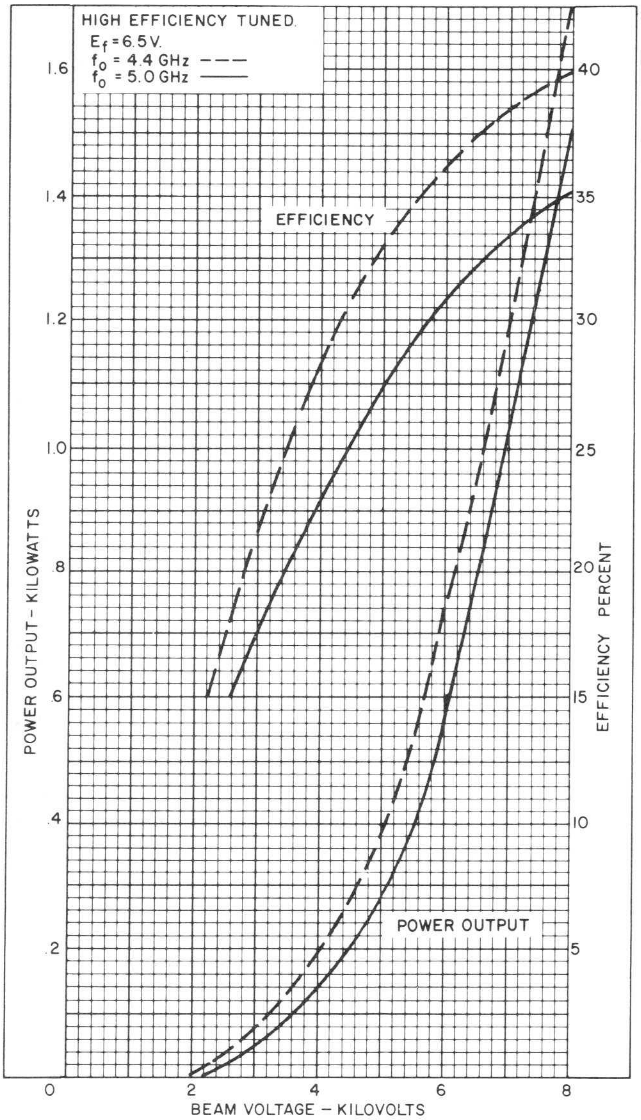


Figure 2 — Output Characteristic Curve

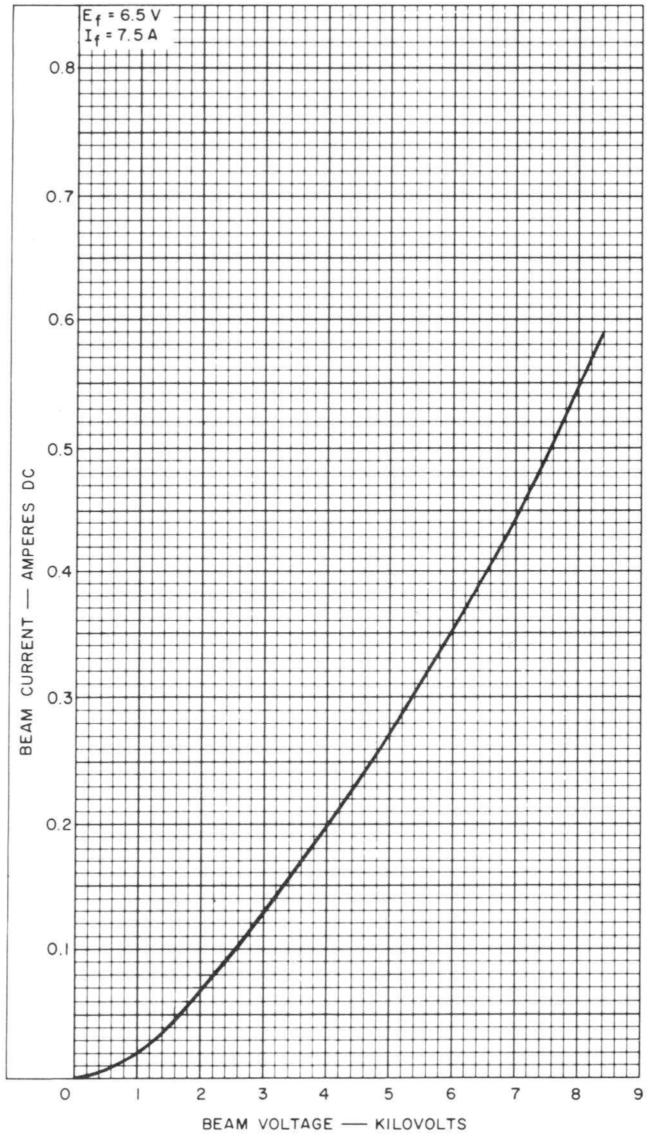


Figure 3 — Beam Current Characteristic Curve

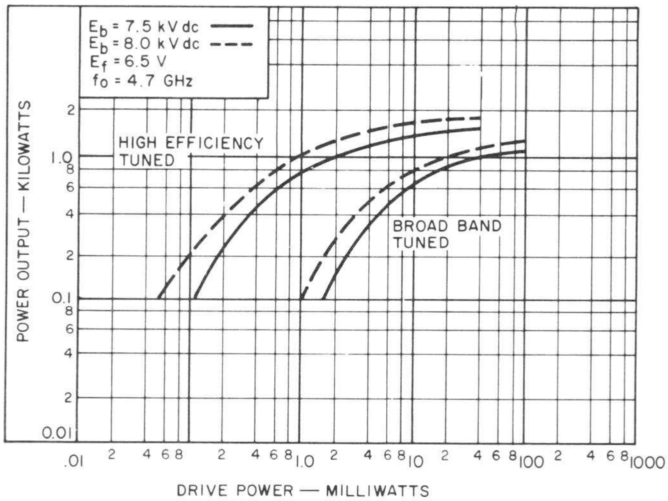


Figure 4 — Gain Characteristic Curve

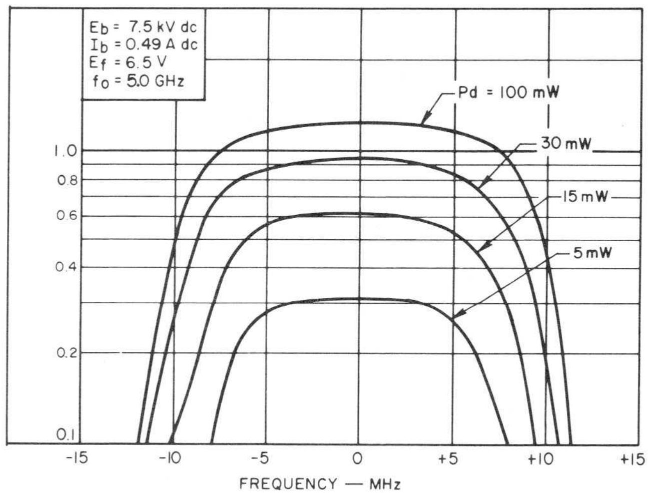
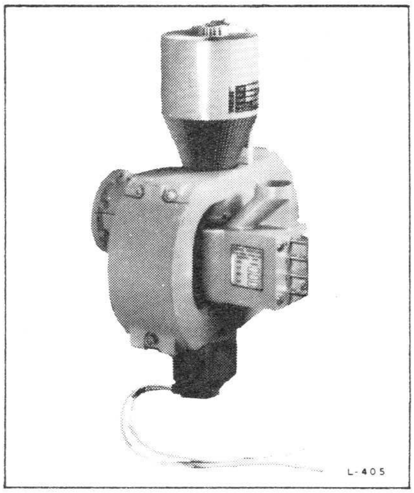


Figure 5 — Bandwidth Characteristic Curve

C Band Klystron



- 5.0 Kilowatts Pulsed Power Output
- High Efficiency — High Power Gain
- Compact — Sturdy
- Gang-Tuned Cavities
- Air Cooled

The RCA 4659 is a permanent-magnet focused, gang-tuned, four cavity klystron designed to deliver in excess of five kilowatts of pulsed power at C-Band for radar applications.

Its light weight, air cooling and permanent magnet focusing, plus high efficiency and high power gain, permit the use of small power supplies and low power drivers to obtain minimum system size, weight and cost.

This data sheet gives information describing the RCA 4659. Supplementary application information, covering handling, installation and operation, may be obtained through your RCA Field Representative, or write RCA Super Power Tube Marketing, Lancaster, PA 17604.

General Data:

Electrical:

Cathode .... Indirectly-Heated Tungsten Dispenser Cathode

Filament

Voltage	6.5 ± 0.5 V
Current (at 6.5 V)	7.6 A
Current (maximum)	8.2 A
Warm-Up Time	180 s

Mechanical:

Mounting Position		Any
Length (maximum)	(393 mm)	15.5 in
Width (maximum)	(267 mm)	10.5 in
Weight (approx.)		
Uncrated	(17.2 kg)	38 lb
In commercial pack	(18.1 kg)	40 lb
In military pack	(22.5 kg)	50 lb

Thermal:

Collector Temperature (maximum)	260 °C
Body Temperature (maximum)	150 °C
Tuner Fin Temperature (maximum)	150 °C
Electron Gun Temperature	
Insulation (maximum)	250 °C
Storage (minimum)	-65 °C

Cooling: Forced air flow across the collector, body and tuner is required.

Typical air-flow requirements
(20° C at sea level pressure)

	Min. Air Flow		Max. Press Drop	
	lbs/min.	kg/min.	in H_2O	cm H_2O
Collector ..	7.5	3.4	2.0	5.1
Body and Tuner	0.85	0.38	0.75	1.9

Typical Rating as a Pulsed RF Amplifier

Maximum Ratings, ***Absolute-Maximum Values:***

Pulsed Beam Voltage	14.0 max.	kV
Pulsed Beam Current	1.6 max.	A
Pulse Width	500	µsec
Duty	0.2	%

Typical Pulsed Operation

Frequency	4.7	GHz
Pulsed Beam Voltage	12.0	kV
Pulsed Beam Current	1.4	A
Pulsed Power Output*	5.0	kW
Power Gain	50.0	dB
Efficiency	30.0	%
Pulse Width	5.0	µsec
Duty	0.2	%

*A waveguide transformer was used to optimize the power output at the stated frequency

Notes for Outline Drawing

1. Mates with Type "N" Connector UG-21 B/U or equivalent.
2. Dimension applies to Shaft No.1 only.
3. Dimension applies to Shafts No.'s 2, 3, and 4 only.
4. Mates with UG-149 A/U or equivalent.
5. Holes 10-32 UNF-2B equally spaced on 3.250" ± .032" (82.6 ± .8 mm) dia. circle.
6. Holes 0.437" ± .062" (11.1 ± 1.6 mm) thru (One side only).
7. High-Voltage Lead Designation
   Heater Lead – Yellow
   Heater-Cathode Lead – White
8. Thru-holes checked with gauge.
9. Three spaces between shafts are 0.70" ± .03" (17.8 ± .8 mm) and add to 2.100" (53.34 mm). Shafts are numbered as shown.
10. Tolerance for this dimension applies to location of four 0.201" (5.11 mm) holes.
11. Hole #6-32 UNC-2B, 0.25" (6.35 mm) minimum depth.

Basic dimensions are in inches unless otherwise stated. Metric equivalents are derived from the basic inch dimensions. (One inch = 25.4 millimeters).

Tabulated Dimensions for the Outline Drawing

Dimension Reference	Specified Values Inches	Millimeters
A	15.5 max.	393.7 max.
B	4.06 ± .12	103.1 ± 3.0
C	1.80 ± .12	45.7 ± 3.0
D	3.5 max.	88.9 max.
E	3.00 ± .06	76.2 ± 1.5
F	3.80 ± .12	96.5 ± 3.0
G	0.68 ± .05	17.3 ± 1.3
H	1.80 ± .09	45.7 ± 2.3
J	0.68 + .15 - .10	17.3 + 3.8 - 2.5
K	6.25 max.	158.8 max.
M	1.50 ± .03	38.1 ± .8
N Dia.	4.12 ± .03	101.6 ± .8
P Dia.	2.130 ± .015	54.10 ± .38
R	10.5 max.	266.7 max.
S	6.5 ± .5	165 ± 13.0
T Dia.	0.250 ±.015	6.35 ± .38
U	13.50 ± .25	343.0 ± 6.0
V	3.25 max.	82.55 max.
W	5.00 ± .06	127.0 ± 1.5
X	2.50 ± .06	63.5 ± 1.5
Y	1.00 ± .06	25.4 ± 1.5
Z	2.00 ± .06	50.8 ± 1.5
AA	3.00 ± .06	76.2 ± 1.5
AB	2.10 ± .02	53.34 ± .51
AC	0.201 ± .010	5.11 ± .25
AD	1.00 ± .03	25.4 ± .8
AE	2.00 ± .03	50.8 ± .8
AF	3.25 ± .02	82.55 ± .51
AG	3.75 ± .03	95.3 ± .8
AH	0.25 ± .03	6.4 ± .8
AJ	0.62 ± .03	15.8 ± .8
AK	0.440 ± .010	11.18 ± .25
AL	0.230 ± .005	5.84 ± .13
AM Dia.	0.249 ± .002	6.325 ± .051
AN	0.125 ± .030	3.2 ± .8
AP	3.00 ± .06	76.2 ± 1.5
AR	4.75 ± .12	120.6 ± 3.0

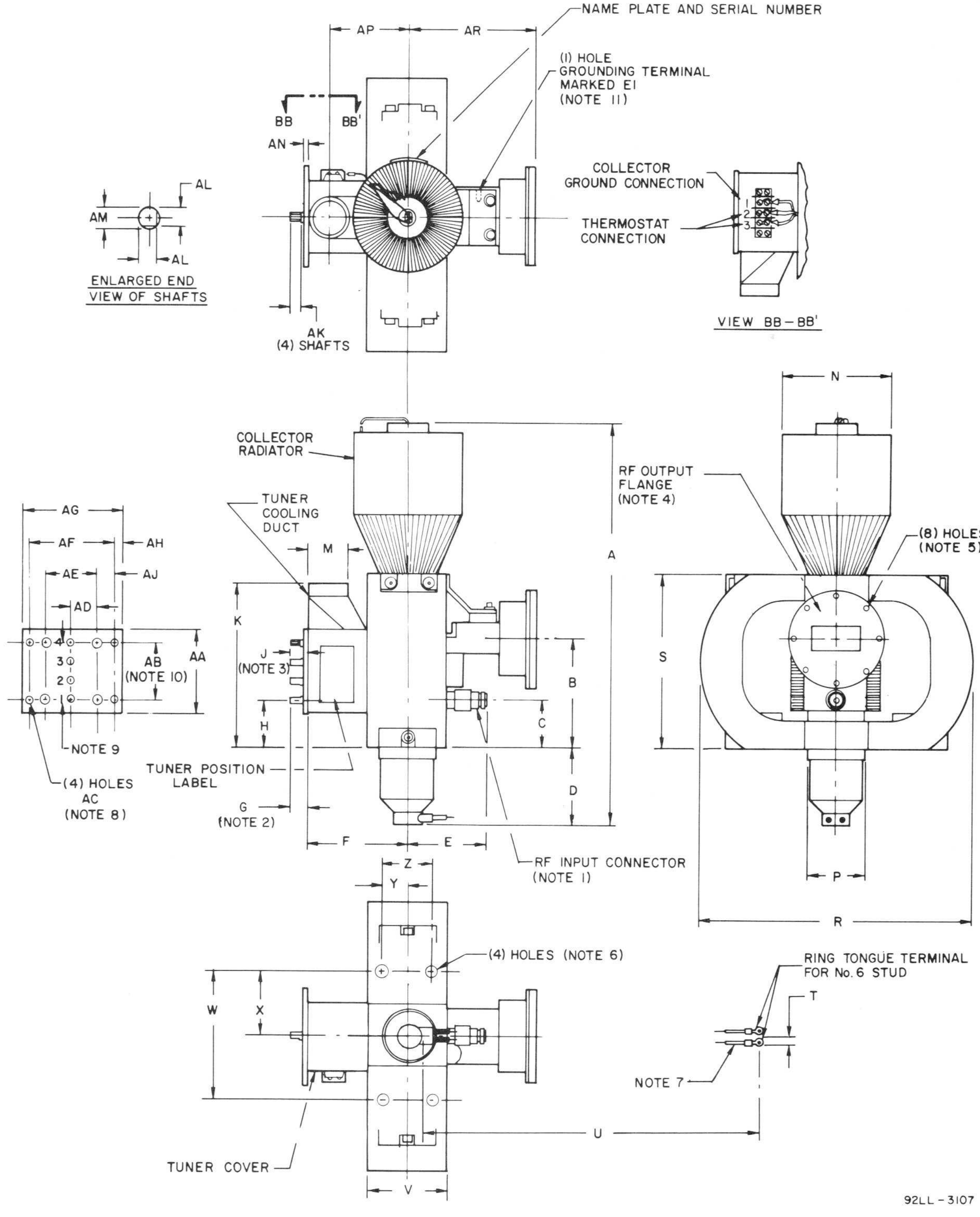


Figure 1 – Dimensional Outline

General Information

Installation and Operation

No installation or operation should be attempted prior to consulting the Installation and Operating instructions shipped with each tube or available upon request from Super Power Tube Marketing, RCA Lancaster, PA 17604.

RCA reference publications helpful for the installation and operation of the RCA 4659 include the following:

Data Sheet – RCA 4659
Application Note – AN 4213
Application Guide – 1CE-279

These publications are available as a complete packet – Request PWR-544, "Application Information for the RCA 4569 Klystron."

Personnel Safety

The high voltages and microwave radiations from this device can be dangerous to life. High voltage shielding and interlock precautions must be taken and all rf connections must be tightly closed and rf terminals shielded.

This device, in operation, may produce X-Radiation which can constitute a health hazard. Shielding or other precautions may be required.

Packaging

Two types of packaging are available with these tubes; Commercial Pack and Military Pack. The customer specifies the desired type.

The Commercial Pack is made of nesting, cardboard cartons with the inner carton shock-mounted. The Military Pack complies with MIL-S-4473C for air shipment. It uses an hermetically-sealed, metal container which protects the tube and serves to shield the surrounding area from stray magnetic fields set up by the klystron focusing magnet.

During shipment, the tube is enclosed in a polyethylene bag to prevent dust and other particles from collecting in the waveguide or tuning systems. It is recommended that the tube be stored in the bag and in the shipping container when not in use. Dust or other unwanted particles in the waveguide can cause arcing during operation and subsequent tube destruction.

Cooling

Air ducts must be provided to connect to the top of the collector and the tuner cooling duct. See the Outline Drawing.

Mounting

Four holes are provided in the gun end of the focusing magnet for mounting purposes. Only non-magnetic studs should be used.

Thermocouple

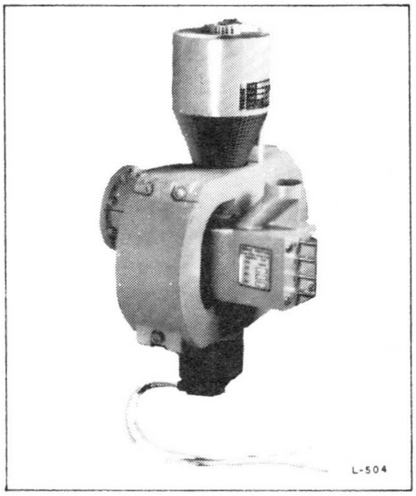
A thermocouple, mounted on the collector, provides a signal which will indicate excessive collector temperature. This output can be used to operate protective circuitry.

Tuning

Tuning is accomplished by a single knob which gang tunes all four cavities simultaneously. The second, third and output cavities may be individually trimmed for optimizing the tube performance at any frequency within the tube operating band. See Outline Drawing.

Protection Circuits

Protection circuits serve a three fold purpose: safety of personnel, protection of the tube, and protection of the circuits. Consult "Application Guide" 1CE-279 for complete information on protection circuits.



C Band Klystron

- 5.0 Kilowatts Pulsed Power Output
- High Efficiency – High Power Gain
- Compact – Sturdy
- Gang-Tuned Cavities
- Air Cooled

The RCA 4660 is a permanent-magnet focused, gang-tuned, four cavity klystron designed to deliver in excess of five kilowatts of pulsed power at C-Band for radar applications.

Its light weight, air cooling and permanent magnet focusing, plus high efficiency and high power gain, permit the use of small power supplies and low power drivers to obtain minimum system size, weight and cost.

This data sheet gives information describing the RCA 4660. Supplementary application information, covering handling, installation and operation, may be obtained through your RCA Field Representative, or write RCA Super Power Tube Marketing, Lancaster, PA 17604.

General Data:

Electrical:

Cathode .... Indirectly-Heated Tungsten Dispenser Cathode

Filament

Voltage	6.5 ± 0.5 V
Current (at 6.5 V)	7.6 A
Current (maximum)	8.2 A
Warm-Up Time	180 s

Mechanical:

Mounting Position		Any
Length (maximum)	(393 mm)	15.5 in
Width (maximum)	(267 mm)	10.5 in
Weight (approx.)		
Uncrated	(17.2 kg)	38 lb
In commercial pack	(18.1 kg)	40 lb
In military pack	(22.5 kg)	50 lb

Thermal:

Collector Temperature (maximum)	260 °C
Body Temperature (maximum)	150 °C
Tuner Fin Temperature (maximum)	150 °C
Electron Gun Temperature	
Insulation (maximum)	250 °C
Storage (minimum)	-65 °C

Cooling: Forced air flow across the collector, body and tuner is required.

Typical air-flow requirements
(20° C at sea level pressure)

	Min. Air Flow		Max. Press Drop	
	lbs/min.	kg/min.	in H_2O	cm H_2O
Collector ..	7.5	3.4	2.0	5.1
Body and Tuner	0.85	0.38	0.75	1.9

Typical Rating as a Pulsed RF Amplifier

Maximum Ratings, ***Absolute-Maximum Values:***

Pulsed Beam Voltage	14.0 max.	kV
Pulsed Beam Current	1.6 max.	A
Pulse Width	500	μsec
Duty	0.2	%

Typical Pulsed Operation

Frequency	4.7	GHz
Pulsed Beam Voltage	12.0	kV
Pulsed Beam Current	1.4	A
Pulsed Power Output*	5.0	kW
Power Gain	50.0	dB
Efficiency	30.0	%
Pulse Width	5.0	μsec
Duty	0.2	%

*A waveguide transformer was used to optimize the power output at the stated frequency

Notes for Outline Drawing

1. Mates with Type "N" Connector UG-21 B/U or equivalent.
2. Dimension applies to Shaft No.1 only.
3. Dimension applies to Shafts No.'s 2, 3, and 4 only.
4. Mates with UG-149 A/U or equivalent.
5. Holes 10-32 UNF-2B equally spaced on 3.250" ± .032" (82.6 ± .8 mm) dia. circle.
6. Holes 0.437" ± .062" (11.1 ± 1.6 mm) thru (One side only).
7. High-Voltage Lead Designation
   Heater Lead – Yellow
   Heater-Cathode Lead – White
8. Thru-holes checked with gauge.
9. Three spaces between shafts are 0.70" ± .03" (17.8 ± .8 mm) and add to 2.100" (53.34 mm). Shafts are numbered as shown.
10. Tolerance for this dimension applies to location of four 0.201" (5.11 mm) holes.
11. Hole #6-32 UNC-2B, 0.25" (6.35 mm) minimum depth.

Basic dimensions are in inches unless otherwise stated. Metric equivalents are derived from the basic inch dimensions. (One inch = 25.4 millimeters).

Tabulated Dimensions for the Outline Drawing

Dimension Reference	Specified Values Inches	Millimeters
A	15.5 max.	393.7 max.
B	4.06 ± .12	103.1 ± 3.0
C	1.80 ± .12	45.7 ± 3.0
D	3.5 max.	88.9 max.
E	3.00 ± .06	76.2 ± 1.5
F	3.80 ± .12	96.5 ± 3.0
G	0.68 ± .05	17.3 ± 1.3
H	1.80 ± .09	45.7 ± 2.3
J	$0.68^{+.15}_{-.10}$	$17.3^{+3.8}_{-2.5}$
K	6.25 max.	158.8 max.
M	1.50 ± .03	38.1 ± .8
N Dia.	4.12 ± .03	101.6 ± .8
P Dia.	2.130 ± .015	54.10 ± .38
R	10.5 max.	266.7 max.
S	6.5 ± .5	165 ± 13.0
T	0.50 ± .12	12.7 ± 3.0
U	15.00 ± .25	381.0 ± 6.0
V	3.25 max.	82.55 max.
W	5.00 ± .06	127.0 ± 1.5
X	2.50 ± .06	63.5 ± 1.5
Y	1.00 ± .06	25.4 ± 1.5
Z	2.00 ± .06	50.8 ± 1.5
AA	3.00 ± .06	76.2 ± 1.5
AB	2.10 ± .02	53.34 ± .51
AD	1.00 ± .03	25.4 ± .8
AE	2.00 ± .03	50.8 ± .8
AK	0.440 ± .010	11.18 ± .25
AL	0.230 ± .005	5.84 ± .13
AM Dia.	0.249 ± .002	6.325 ± .051
AP	3.00 ± .06	76.2 ± 1.5
AR	4.75 ± .12	120.6 ± 3.0

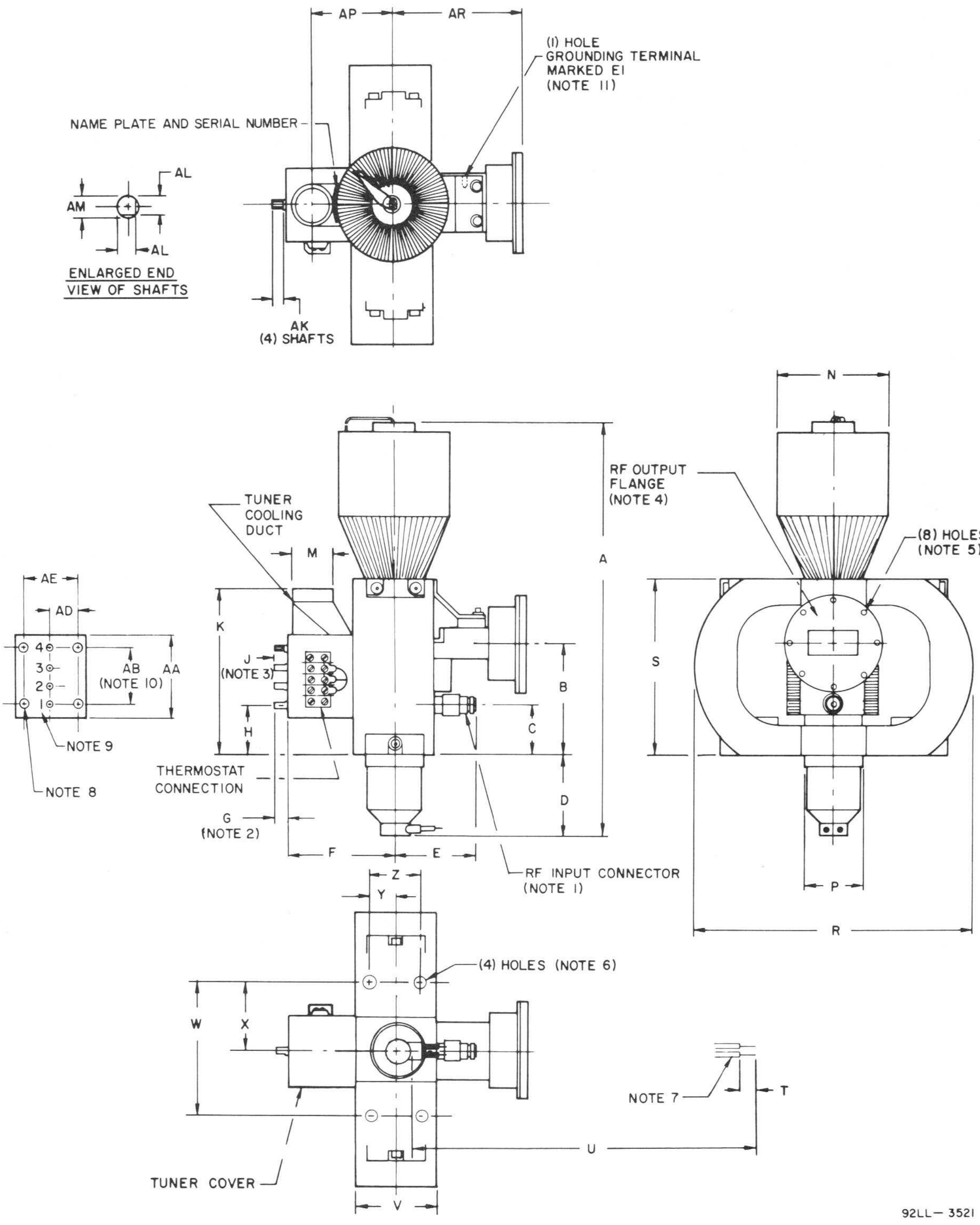


Figure 1 – Dimensional Outline

General Information

Installation and Operation

No installation or operation should be attempted prior to consulting the Installation and Operating instructions shipped with each tube or available upon request from Super Power Tube Marketing, RCA Lancaster, PA 17604.

RCA reference publications helpful for the installation and operation of the RCA 4660 include the following:

Data Sheet – RCA 4660
Application Note – AN 4213
Application Guide – 1CE-279

These publications are available as a complete packet – Request PWR-545, "Application Information for the RCA 4660 Klystron."

Personnel Safety

The high voltages and microwave radiations from this device can be dangerous to life. High voltage shielding and interlock precautions must be taken and all rf connections must be tightly closed and rf terminals shielded.

This device, in operation, may produce X-Radiation which can constitute a health hazard. Shielding or other precautions may be required.

Packaging

Two types of packaging are available with these tubes; Commercial Pack and Military Pack. The customer specifies the desired type.

The Commercial Pack is made of nesting, cardboard cartons with the inner carton shock-mounted. The Military Pack complies with MIL-S-4473C for air shipment. It uses an hermetically-sealed, metal container which protects the tube and serves to shield the surrounding area from stray magnetic fields set up by the klystron focusing magnet.

During shipment, the tube is enclosed in a polyethylene bag to prevent dust and other particles from collecting in the waveguide or tuning systems. It is recommended that the tube be stored in the bag and in the shipping container when not in use. Dust or other unwanted particles in the waveguide can cause arcing during operation and subsequent tube destruction.

Cooling

Air ducts must be provided to connect to the top of the collector and the tuner cooling duct. See the Outline Drawing.

Mounting

Four holes are provided in the gun end of the focusing magnet for mounting purposes. Only non-magnetic studs should be used.

Thermocouple

A thermocouple, mounted on the collector, provides a signal which will indicate excessive collector temperature. This output can be used to operate protective circuitry.

Tuning

Tuning is accomplished by a single knob which gang tunes all four cavities simultaneously. The second, third and output cavities may be individually trimmed for optimizing the tube performance at any frequency within the tube operating band. See Outline Drawing.

Protection Circuits

Protection circuits serve a three fold purpose: safety of personnel, protection of the tube, and protection of the circuits. Consult "Application Guide" 1CE-279 for complete information on protection circuits.

New Product Announcement

Electronic Components
Harrison, NJ 07029

RCA

International Licensing
Licensee Services

Linear RF Beam Power Tube

RCA-4661

The RCA-4661 is designed specifically for use in high altitude communication equipment. Its ruggedized construction and long ceramic make it ideally suitable for airborne service where unpressurized equipment is used in linear, low-noise applications.

It is similar in construction to the 8792 except for the cutout on the fin assembly and a longer ceramic. The cutouts were included to permit cooling by directing the air radially to the tube anode in a Collins transmitter. The longer ceramic assures the required high-altitude voltage hold-off.

The air flow data reflects the requirements of the 8792. The 4661 will need the same weight of air, but has a lower differential pressure drop than the 8792.

This tube is now available for use in current equipment design.

June 15, 1970

CERMOLOX® Beam Power Tube

- Ruggedized
- Reliable
- Forced-Air Cooled
- Matrix Cathode
- Full Input to 400 MHz
- Over 1000 Watts CW FM
- Over 250 Watts CW AM Linear

The RCA 4661* is designed specifically to meet the low noise and stringent environmental conditions in unpressurized, airborne communication service. In these equipments it is rated for both FM and linear-AM telephony operation. In FM telephony service the 4661 can deliver 1160 watts of useful, CW power output at a bandwidth of 4.4 MHz and a gain of 12 dB. As an AM linear amplifier the 4661 can deliver 280 watts of useful CW power output at 4.5 MHz bandwidth and 12 dB gain.

The sturdy, coaxial, CERMOLOX tube construction minimizes tube inductances and feed-thru capacitances. This enables the use of straight-forward cavity circuit-design techniques for operation up to 500 MHz and also minimizes induced noise problems in linear systems. Its efficient, forced-air-cooled radiator reduces blower-noise problems and increases overall system efficiency, while the rugged matrix cathode increases system reliability.

To assure compliance with environmental design objectives, sample tubes are regularly subjected to 15g-11-millisecond shock, and up to 10g-5 to 500 hertz vibration testing.

This bulletin gives application information unique to the RCA 4661. General information, covering the installation and operation of this tube type, is given in the "Application Guide for RCA Power Tubes", 1CE-300. Close attention to the instructions contained therein will assure longer tube life, safer operation, less equipment downtime, and fewer tube-handling accidents.

*Formerly RCA Dev. No.A2921.

General Data

Electrical:

Heater-Cathode:		
Type	Unipotential, Oxide Coated, Matrix Type	
Voltage[a] (AC or DC)	5.5 typ.	V
	5.8 max.	V
Current (@ 5.5 V)	17.3	A
Minimum heating time	180	s
Mu Factor[b] (Grid No.1 to Grid No.2)	6.5	
Direct Interelectrode Capacitances:		
Grid No.1 to plate[c]	0.14	pF
Grid No.1 to Cathode-Heater	38	pF
Plate to Cathode-Heater[c]	0.02	pF
Grid No.1 to Grid No.2	52	pF
Grid No.2 to Plate	13	pF
Grid No.2 to Cathode-Heater[c]	1.4	pF

Mechanical:

Operating Position	Any
Maximum Length	(98.0 mm) 3.86 in
Greatest Diameter	(94.7 mm) 3.73 in
Terminal Connection	See Dimensional Outline
Socket	See page 6
Radiator	Integral part of tube
Weight (Approx.)	(0.9 kg) 2 lbs

Thermal:

Ceramic-Metal Interface Temperature[d] (Plate, grid No.1, grid No.2, cathode-heater, and heater)	250 max. °C
Plate Core Temperature[d]	250 max. °C

Linear RF Power Amplifier[e]
AM Telephony Service, Class AB

Carrier conditions for use with a maximum modulation factor of 1.0

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC Plate Voltage[f]	3500	max.	V
DC Grid-No.2 Voltage[g]	1000	max.	V
DC Grid-No.1 Voltage[h]	-300	max.	V
DC Plate Current	700	max.	mA
Grid-No.2 Input	50	max.	W
Plate Dissipation	1500	max.	W

Calculated CCS Operation as a Class AB_1 Amplifier:

In a cathode-drive circuit at 400 MHz with an output circuit bandwidth of 4.5 MHz[j].

DC Plate Voltage	2600	V
DC Grid-No.2 Voltage	550	V
DC Grid-No.1 Voltage[k]	-75	V
DC Plate Current	490	mA
DC Grid-No.2 Current	-15	mA
DC Grid-No.1 Current	0	mA
Drive Power (Approx.)	18	W
Output Circuit Eff. (Approx.)	90	%
Useful Power Output	280	W

RF Power Amplifier & Oscillator – Class C Telegraphy[e] and RF Power Amplifier – Class C FM Telephony[e]

Maximum CCS Ratings, *Absolute-Maximum Values:*

	up to 400 MHz		
DC Plate Voltage[f]	3500	max.	V
DC Grid-No.2 Voltage[g]	1000	max.	V
DC Grid-No.1 Voltage[h]	-300	max.	V
DC Plate Current	1.25	max.	A
DC Grid-No.1 Current	0.2	max.	A
Grid-No.2 Input[g]	50	max.	W
Plate Dissipation	1500	max.	W

Maximum Circuit Values:

Grid-No.1-Circuit Resistance	5000 max. Ω
Grid-No.2-Circuit Impedance	See note **g**
Plate-Circuit Impedance	See note **f**

Calculated CCS Operation:

In a cathode-drive circuit at 400 MHz with an output circuit bandwidth of 4.4 MHz[j].

DC Plate Voltage	2600	V
DC Grid-No.2 Voltage	550	V
DC Grid-No.1 Voltage[m]	-85	V
DC Plate Current	900	mA
DC Grid-No.2 Current	-10	mA
DC Grid-No.1 Current	5	mA
Drive Power (Approx.)	70	W
Output Circuit Eff. (Approx.)	90	%
Useful Power Output	1160	W

Notes:

a See Section V.A.3 of 1CE-300.

b For: plate voltage = 2500 V
grid No.2 voltage = 600 V
plate current = 600 mA

c With special shield adapter.

d See Dimensional Outline for temperature measurement points.

e See Section V.C. of 1CE-300.

f See SectionV.B. and V.B.1 of 1CE-300.

g See Section V.B.2 of 1CE-300.

h See Section V.B.3 of 1CE-300.

j Computed between half-power points using two times tube capacity.

k Adjust for zero-signal DC plate current of 0.2 A.

m Adjust for zero-signal DC plate current of 0.1 A.

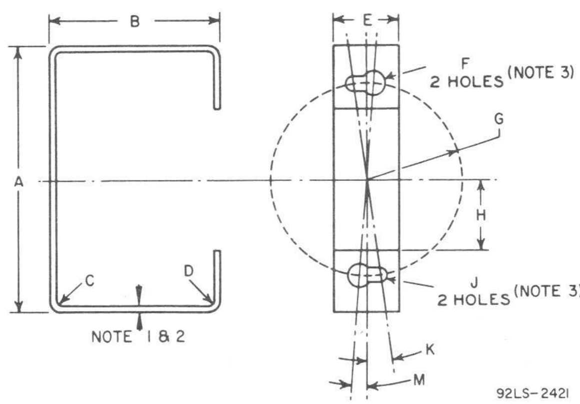


Figure 1 – Tube Extractor – Suggested Design

Tabulated Dimensions*

Dim.		Values	
A		2.8	(71.)
B		1.8	(46.)
C	Radius	0.06	(1.5)
D	Radius	0.06	(1.5)
E		0.7	(18.)
F	Dia.	0.250	(6.35)
G	Radius	1.015	(25.78)
H		0.75	(19.)
J	Dia.	0.140	(3.56)
K		8.3°	0.145 radians
M		4.5°	0.078 radians

Notes:

1. Material 1/16" thick cold rolled steel.
2. Round all edges
3. Slot between holes

*Dimensions are in inches unless otherwise stated. Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions (1 inch = 25.4 mm).

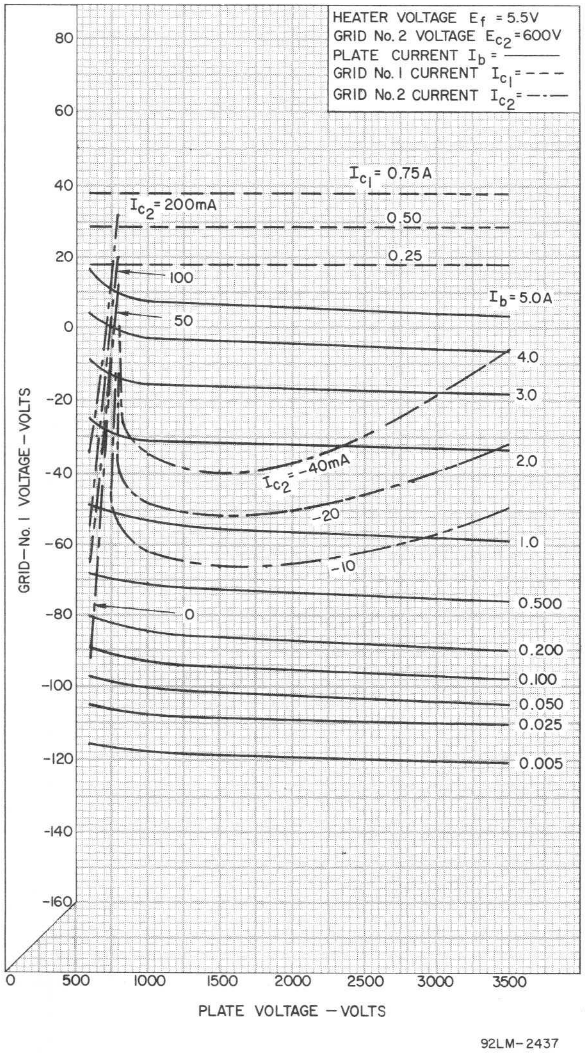


Figure 2 – Typical Constant Current Characteristics (E_{c_2} = 600 V)

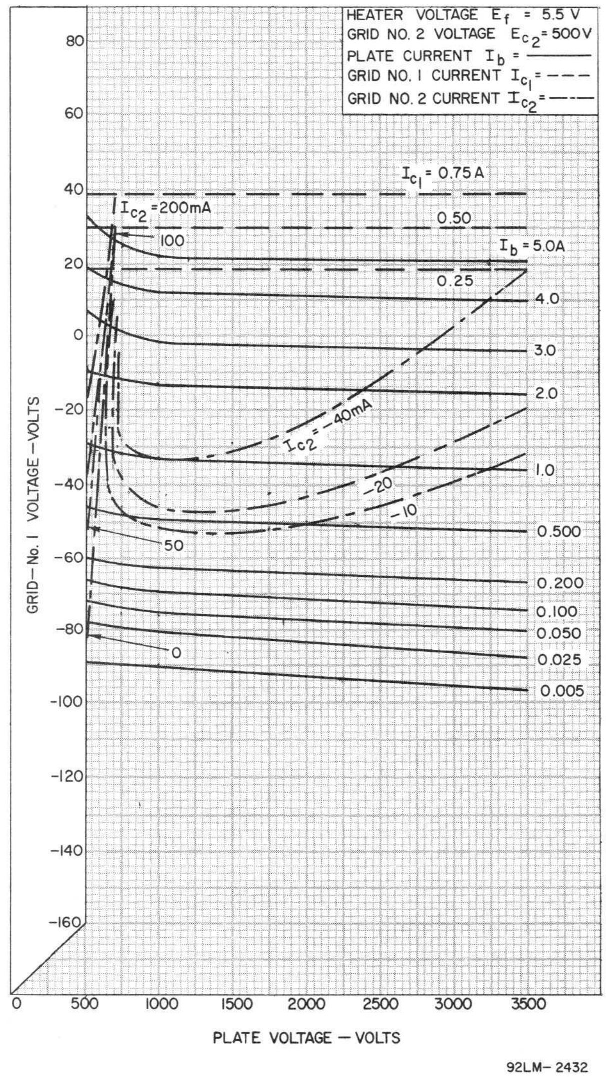


Figure 3 – Typical Constant Current Characteristics (E_{c_2} = 500 V)

Mounting

See the preferred mounting arrangement below. See section III.C.3.a of 1CE-300 for a description of the fixed method mounting. The adjustable method is not recommended for the 4661. Special sockets are available.

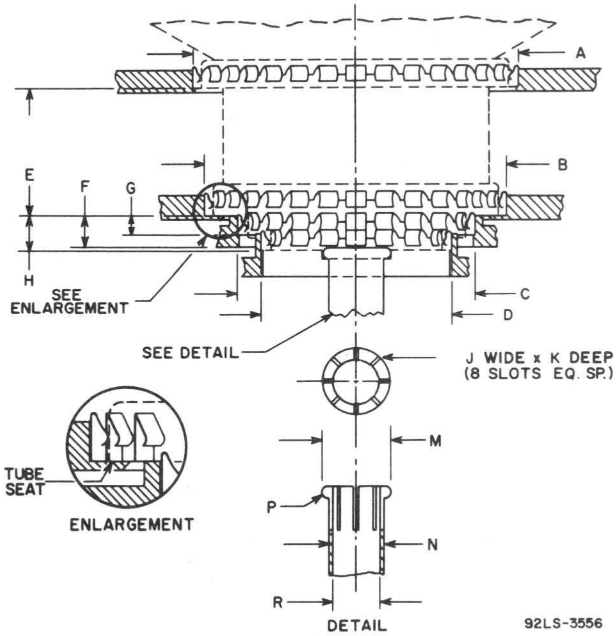


Figure 6 – Preferred Mounting Arrangement

Note: Finger stock is No.97-360A made by Instrument Specialities Co., Little Falls, NJ 07424.

Sockets may be obtained from:

Erie Technological Products, Inc.
644 West 12th Street, Erie, PA 16512

Jettron Products Incorporated
56 Route 10, Hanover, NJ 07936

Tabulated Dimensions*

Dim.	Value
A Dia.	3.425 (87.00)
B Dia.	3.210 (81.53)
C Dia.	2.505 (63.63)
D Dia.	1.912 (48.56)
E	1.320 (36.07)
F	0.330 (8.38)
G	0.200 (5.08)
H	0.370 (9.40)
J	0.025 (0.64)
K	0.500 (12.70)
M Dia.	0.725 (18.42)
N Dia.	0.594 (15.09)
P Radius	0.062 (1.57)
R Dia.	0.500 (12.70)

*Dimensions are in inches unless otherwise stated. Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions (1 inch = 25.4 mm).

Forced-Air Cooling

Air Flow:

Through radiator – Adequate air flow to limit the plate-core temperature to 250° C should be delivered by a blower through the radiator before and during the application of heater, plate, grid-No.2, and grid-No.1 voltages. In typical operation at 1500 watts plate dissipation, and 225° C plate core temperature, 35 cfm at 0.50 inch water, static pressure drop, at 50° C ambient air temperature at one atmosphere, should be sufficient as shown in the Coolant Characteristic curves of **Figure 7.**

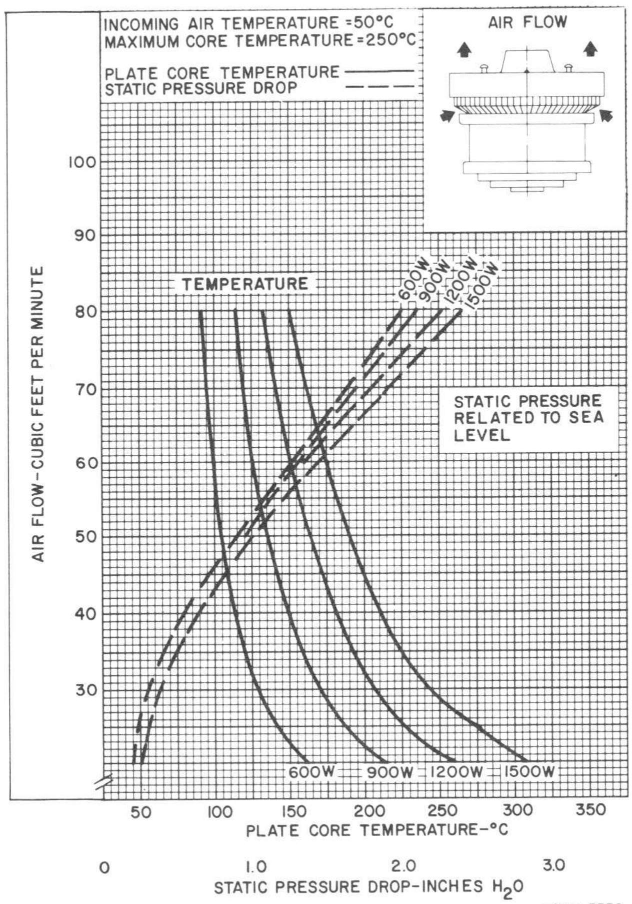


Figure 7 -- Coolant Characteristics

The static pressure drop has been determined conservatively and in all instances the tube should excel the indicated performance.

To Plate, Grid-No.2, Grid-No.1, Cathode-Heater, and Heater Terminals – A sufficient quantity of air should be allowed to flow past each of these terminals so that their temperature does not exceed the specified maximum value of 250° C.

During Standby Operation – Cooling air is required when only heater voltage is applied to the tube.

During Shutdown Operation – Air flow should continue for a few minuted after all electrode power is removed.

For further information on forced-air cooling, see section IV.C of 1CE-300.

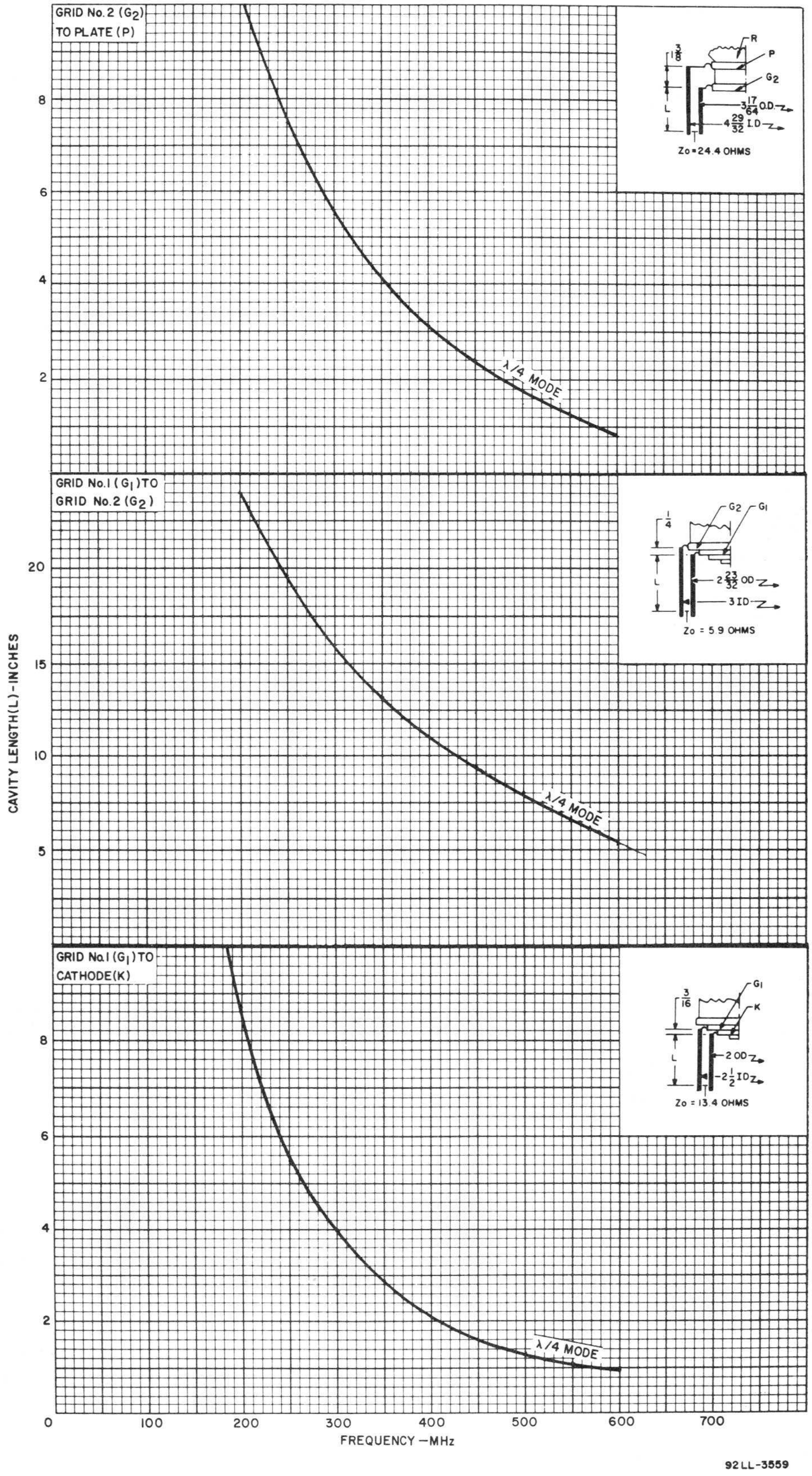


Figure 4 – Electrode Cavity Tuning Characteristics

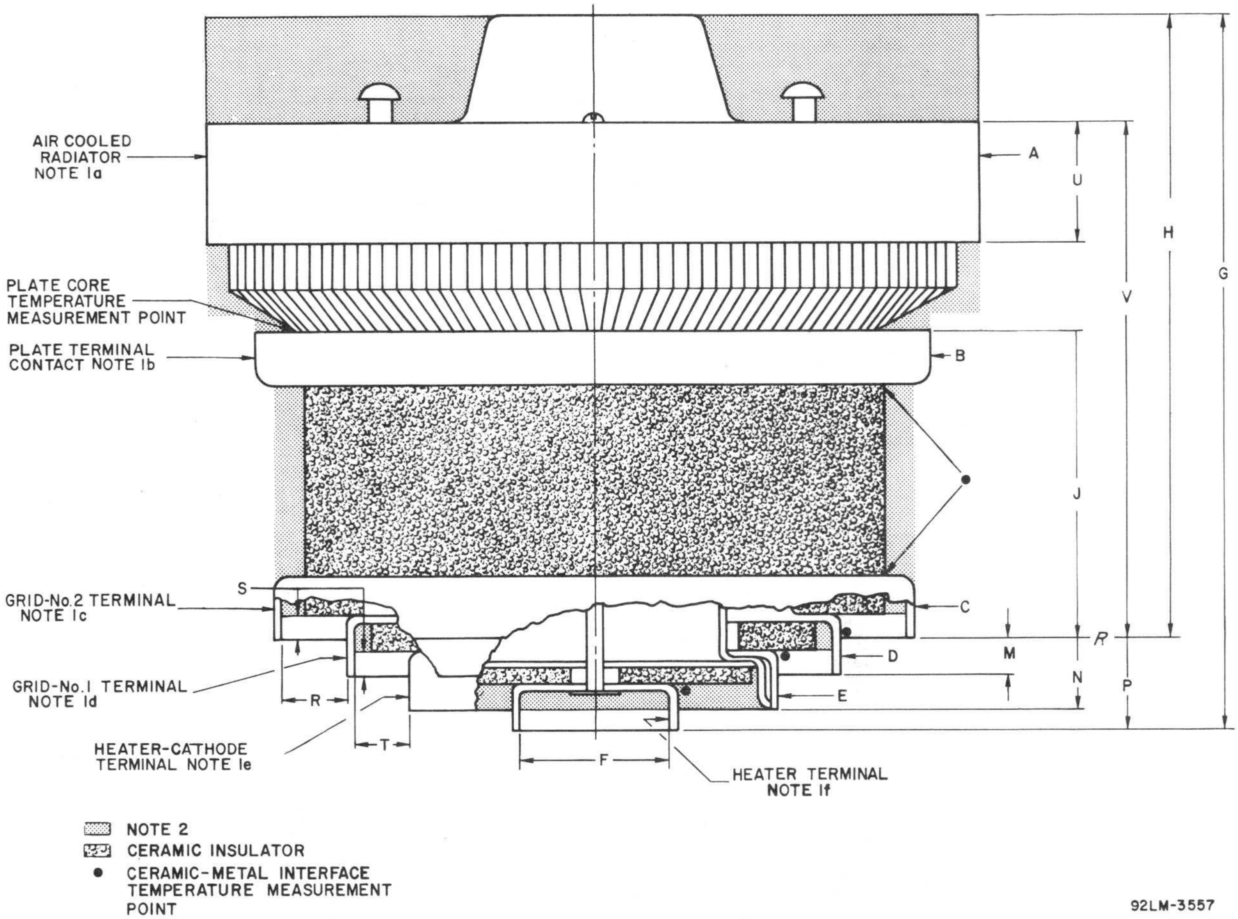


Figure 5 – Dimensional Outline

Tabulated Dimensions*

Dimension	Value: Inches	Value: Millimeters
A Dia.	3.70 ±.03	93.98 ±.76
B Dia.	3.210 min.	81.54 min.
C Dia.	3.010 min.	76.45 min.
D Dia.	2.307 min.	58.60 min.
E Dia.	1.700 min.	43.18 min.
F Dia.	0.725 max.	18.41 max.
G	3.76 ±.10	95.5 ±2.5
H	3.30 ±.10	83.8 ±2.5
J	1.65 ±.03	41.91 ±.76
M	0.200 ±.025	5.08 ±.64
N	0.37 ±.03	9.40 ±.76
P	0.46 ±.03	11.68 ±.76
R	0.250 min.	6.35 min.
S	0.105 min.	2.67 min.
T	0.200 min.	5.08 min.
U	0.620 min.	15.75 min.
V	2.71 ±.10	68.8 ±2.5

Note 1: The contact distance* indicated is the minimum uniform length as measured from the edge of the terminal.

Terminal	Dimensional Value: Inches	Dimensional Value: Millimeters
1.a Radiator	0.620	15.75
1.b Plate	0.220	5.59
1.c Grid No.2	0.220	5.59
1.d Grid No.1	0.175	4.45
1.e Heater-Cathode	0.115	2.92
1.f Heater	0.135	3.43

Note 2: Keep all stippled regions clear. In general do not allow contacts to protrude into these annular regions. If special connectors are required which may intrude on these regions, contact RCA Power Tube Application Engineering, Lancaster, PA, for guidance.

*Basic dimensions are in inches unless otherwise specified. Metric dimensions are derived from the basic inch dimensions (One inch = 25.4 mm).

RCA electron tube ANNOUNCEMENT

A NEW TUBE..... AN IMPROVED TUBE..... SPECIAL INFORMATION

RADIO CORPORATION OF AMERICA
RCA INTERNATIONAL DIVISION
HARRISON, NEW JERSEY

LICENSEE SERVICE

May 9, 1963

RCA-5651A
MINIATURE VOLTAGE-REFERENCE TUBE
For Exceptional Voltage Stability

Gentlemen:

RCA is pleased to announce the 5651A -- a voltage-reference tube of the cold-cathode glow-discharge type having exceptional voltage stability. It is particularly useful in critical industrial and military dc power supplies incorporating electronic voltage regulation. RCA-5651A is similar to and unilaterally interchangeable with the popular 5651 but has substantially greater voltage stability, and can be used as a direct replacement for the 5651 in existing equipment. The 5651A features:

→ exceptionally small voltage drift throughout life:
  a) during first 300 hours of operation
     (from initial dc operating voltage) -- no greater than 0.1 percent
  b) between 300 and 1300 hours of operation
     (from dc operating voltage at 300 hours) -- no greater than 0.1 percent
  c) during any 100-hour period between
     300 and 1300 hours of operation -- no greater than .05 percent

→ small variation in initial tube drop -- only 4 volts max. at any specific current value

→ excellent voltage stability not only initially but throughout life -- instantaneous voltage fluctuation less than 0.1 volt at any current value within operating current range (1.5 to 3.5 ma)

→ operating characteristic -- essentially independent of ambient temperature in the -55°C to +90°C range.

The exceptional performance of the 5651A is due to:

→ long aging schedule -- to stabilize tube characteristics

→ special cathode design -- assures utilization of entire cathode area at all current values within operating current range

→ thin metallic coating on inside of envelope -- to minimize slow voltage drift

A technical bulletin for the 5651A is attached.

Very truly yours,

R F Simokat

R.F. SIMOKAT
Licensee Service

RFS/mg

RCA-5651A
VOLTAGE-REFERENCE TUBE

Glow-Discharge Tube | 7-PIN MINIATURE TYPE | For Exceptional Voltage Stability

RCA-5651A is a 7-pin miniature, voltage-reference tube of the cold-cathode, glow-discharge type. Because of its exceptionally stable voltage characteristic the 5651A is especially useful as a voltage-reference tube in dc power supplies. The 5651A maintains a dc operating voltage of 85.5 volts at 2.5 milliamperes, has a dc operating current range of 1.5 to 3.5 milliamperes, and an operating characteristic which is essentially independent of ambient temperature in the -55 to +90° C range. The maximum variation in initial tube drop at any specific current value is only 4 volts.

The 5651A is life tested to assure that the tubes provide exceptional voltage stability. During the first 300 hours of operation the voltage drift from the initial dc operating voltage is no greater than 0.1%; between 300 and 1300 hours of operation the voltage drift is no greater than 0.1% from the dc operating voltage at 300 hours. Furthermore, the voltage drift during any 100-hour period between 300 and 1300 hours of operation is no greater than 0.05%.

The excellent performance of the 5651A is largely due to its special design in which the entire cathode area is utilized at all current values within the operating current range, and a long aging schedule to stabilize the tube characteristics. Another feature of this tube is the use of a thin metallic coating on the inside of the glass envelope to minimize slow voltage drift.

DATA

General:

Cathode	Cold
Operating Position	Any
Maximum Overall Length	2-1/8"
Maximum Seated Length	1-7/8"
Length, Base Seat to Bulb Top (Excluding tip)	1-1/2" ± 3/32"
Diameter	0.650" to 0.750"
Bulb	T5-1/2
Base	Small-Button Miniature 7-Pin (JEDEC No.E7-1)
Dimensional Outline	JEDEC No.5-2

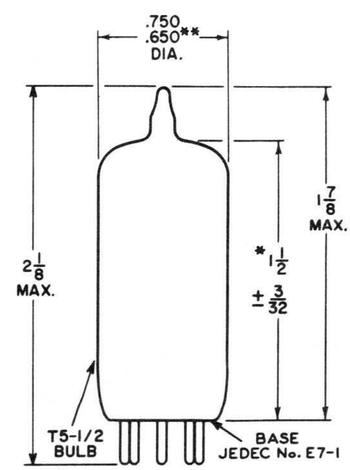
Maximum and Minimum Ratings, *Absolute-Maximum Values:*

DC Operating Current (Continuous)	3.5 max.	ma
DC Operating Current (Continuous)	1.5 min.	ma
Ambient Temperature Range	-55 to +90	°C

Characteristics and Operation Range Values:

	Min.	*Av.*	*Max.*	
DC Starting Voltage	-	107	115[a]	volts
DC Operating Voltage (Variation from tube to tube):				
At 1.5 ma	83	85	87	volts
At 2.5 ma	83.5	85.5	87.5	volts
At 3.5 ma	84.5	86.5	88.5	volts
Regulation (1.5 ma to 3.5 ma)	-	-	3	volts
Temperature Coefficient of Operating Voltage (over ambient temperature range of -55 to +90° C)	-	-4	-	mv/°C

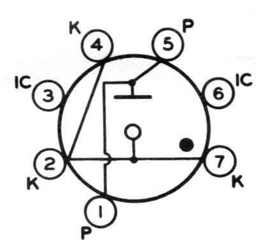
[a] A dc supply voltage of 115 volts minimum should be provided to insure "starting" throughout tube life.



All Dimensions in Inches

* Measured from base seat to bulb-top line as determined by ring gauge of 7/16" I.D.

** Applies in zone starting 0.375" from base seat.



5BQ

Pin 1 – Anode
Pin 2 – Cathode
Pin 3 – IC—Do Not Use
Pin 4 – Cathode
Pin 5 – Anode
Pin 6 – IC—Do Not Use
Pin 7 – Cathode

Percentage Variation of Operating Voltage:[b]				
During first 300 hours of life[c]	-	-	0.1	%
During subsequent 1000 hours of life	-	-	0.1	%
Short-term (100 hours) Variation of Operating Voltage after first 300 hours of life[b]	-	-	0.05	%
Instantaneous Voltage Fluctuation (Voltage Jump)[d]	-	-	0.1	volt

Circuit Values:

Shunt Capacitor	-	-	0.02	μf
Series Resistor	Note e			

[b] DC operating current = 2.5 ma.

[c] After initial 3-minute warm-up period.

[d] Defined as the maximum instantaneous voltage fluctuation at any current level within the operating current range.

[e] A series resistor must always be used with the 5651A. The resistance value must be chosen so that (1) the maximum current rating of 3.5 ma is not exceeded at the highest anode-supply voltage employed, and (2) the minimum current rating of 1.5 ma is always exceeded when the anode-supply voltage is at its lowest value.

SPECIAL TESTS AND PERFORMANCE DATA

Stability Life Performance:

This test is performed on a sample lot of tubes to assure that the tubes have been properly stabilized. Life testing is performed under the following conditions: DC anode-supply volts = 135, dc operating milliamperes = 2.5, anode-circuit resistance (ohms) = 20000. At the end of 300 hours of operation, tubes will not show a change in dc operating voltage greater than 0.1% from the initial dc operating voltage. At the end of 1300 hours of operation, tubes will not show a change in dc operating voltage greater than 0.1% from the operating voltage at 300 hours. During any 100-hour interval between 300 and 1300 hours of operation, tubes will not show a change in dc operating voltage greater than 0.05% from the dc operating voltage at the start of the interval.

INSTALLATION AND APPLICATION

Make no connections to pins 3 and 6. Any potentials applied to these pins may cause erratic tube performance. The three pin terminals for the cathode (pins 2, 4, and 7) and the two for the anode (pins 1 and 5) offer the equipment designer several different possibilities for connection of the 5651A. Any pair of interconnected pins can be used as a jumper connection to a circuit common to either the cathode or to the anode. The use of such a jumper connection provides a means for opening the circuit to protect circuit components when the 5651A is removed from its socket. *Under no circumstances should the current through any pair of interconnected pins exceed one ampere.*

If the load for the regulated power supply is disconnected either directly or by removing the 5651A from its socket, the rectifier capacitors will charge to the rectifier peak voltage. It is important, therefore, that these capacitors be rated to withstand such voltage.

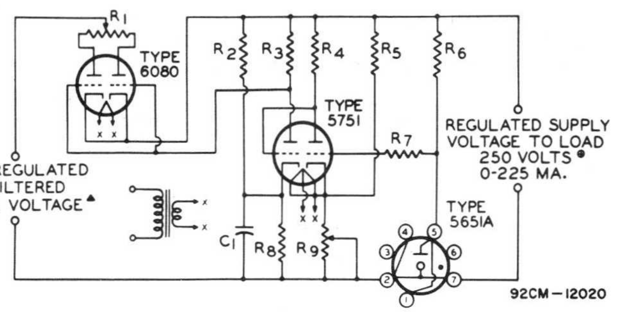
A warm-up period of 3 minutes should be allowed each time the equipment is turned on to insure minimum voltage drift of the 5651A.

When a shunt capacitor is used with the 5651A, its value should be limited to 0.02 μf. A large value of capacitance may cause the tube to oscillate and thus give unstable performance.

Shielding should be utilized for the 5651A to insure maximum stability when the tube is operated in the presence of strong rf or magnetic fields.

A series-type stabilized voltage supply using the 5651A as voltage-reference tube, 6080 as series-regulator tube, and 5751 as control tube, is shown in *Fig. 1*. In this circuit, the 5651A supplies a fixed reference voltage between the grid of the first unit of the 5751 and its cathode return. Changes in supply voltage to the load are amplified by the 5751 which is connected as a two-stage dc amplifier to control the drop through the 6080. The resulting output voltage is essentially independent of change in load current.

The voltage regulation of this supply operated at a fixed line voltage of 117 volts and an output voltage of 250 volts is less than 0.2 volt over the current range of 0 to 225 milliamperes. At full current, the regulation for a variation of ± 10 per cent in line voltage is less than 0.1 volt.



C_1 – 0.1 μf, 400 volts
R_1 – Plate current balancing potentiometer, 160 ohms, 10 watts
R_2 – 12000 ohms, 2 watts
R_3 – 470000 ohms, 1/2 watt
R_4 – 470000 ohms, 1/2 watt
R_5 – 12000 ohms, 2 watts
R_6 – 68000 ohms, 1 watt
R_7 – 1 megohm, 1/2 watt
R_8 – 15000 ohms, 2 watts
R_9 – Output voltage-control potentiometer, 10000 ohms

▲ 375 volts approx. at zero load current; 325 volts approx. at 225 milliamperes load current.

⊕ Socket connections for the 5651A are made so that removal of the 5651A from its socket opens the load.

Fig.1 - Series-Type Stabilized Voltage Supply Using RCA-5651A as Voltage-Reference Tube.

RCA electron tube ANNOUNCEMENT

A NEW TUBE..... AN IMPROVED TUBE..... SPECIAL INFORMATION

RADIO CORPORATION OF AMERICA
RCA INTERNATIONAL DIVISION
HARRISON, NEW JERSEY

LICENSEE SERVICE

May 15, 1961

NEW RCA-5762-A
AN IMPROVED POWER TRIODE
FOR VHF TELEVISION

Gentlemen:

RCA-5762-A is a new forced-air-cooled power triode for vhf service in television and cw application. The 5762-A is unilaterally interchangeable with the 5762/7C24, having improved qualities for fm applications and increased ratings. It has a maximum plate dissipation of 4 kilowatts and is rated for operation up to 220 Mc.

The 5762-A retains the very efficient radiator for low blower requirements; the thoriated tungsten filament for economical power consumption; and complete shielding between filament leads and plate, low grid-to-plate capacitance, and high perveance for use in grounded-grid circuits to provide stable triode performance at high frequencies.

In broadband television service at 216 Mc, the 5762-A can deliver a synchronizing-level power output of 6.35 kilowatts when supplied by a driving power of 0.98 kilowatts.

The attached technical bulletin gives ratings, characteristics, typical operating conditions, dimensions, and operating considerations for the 5762-A.

Very truly yours,

R F Simokat

R.F. SIMOKAT
Licensee Service

RFS:mlm

5762-A

POWER TRIODE

Thoriated-Tungsten Filament	For Use at Frequencies up to 220 Mc	Max. Diameter 4-11/16"
Coaxial-Electrode Structure	Forced-Air Cooled	Max. Length (Excluding
Large Area RF Contact Surfaces	4 Kw Plate Dissipation	flexible leads) 7-1/8"

RCA-5762-A is a forced-air-cooled power triode designed for vhf service in television and cw applications. It has a maximum plate dissipation of 4 kilowatts and is rated for operation up to 220 megacycles per second.

The flanged-header grid terminal is a design feature of particular value when the 5762-A is used in cathode-drive (also called grounded-grid) circuits. In such circuits this terminal, when used with a large circular connector, effectively isolates the filament circuit from the plate circuit, and provides a direct low-inductance path to the grid. As a result, neutralization is generally unnecessary in cathode-drive service.

The design of the 5762-A includes three multiple-ribbon filament leads, one of which is a center tap to facilitate the reduction of filament-lead inductance in high-frequency circuits. Within the tube, the leads to the thoriated-tungsten filament are short and direct. An efficient external radiator provides for plate cooling by means of forced air. The conical grid support is structurally strong, serves to cool the grid, and effectively reduces grid-lead inductance. These various design features all contribute to the excellent performance of the 5762-A in very-high-frequency applications.

The 5762-A can deliver a synchronizing-level power output of 6.35 kilowatts in broad-band television service at 216 Mc; a carrier power output of 3.7 kilowatts in plate-modulated telephony service using conventional grid-drive circuits at frequencies up to 30 Mc; and a power output of 7 kilowatts in class C telegraphy service using cathode-drive circuits at frequencies up to 30 Mc, or 4 kilowatts at 220 Mc.

The 5762-A is unilaterally interchangeable with the 5762/7C24.

GENERAL DATA

Electrical:

Filament, Thoriated Tungsten:

Voltage (AC or DC)	12.6 ± 0.6	volts
Current	29	amperes
Starting current: The filament current must never exceed 175 amperes, even momentarily		
Cold resistance	0.052	ohm
Amplification Factor	29	
Direct Interelectrode Capacitances:		
Grid to plate	18	$\mu\mu$f
Grid to filament	19	$\mu\mu$f
Plate to filament	0.5	$\mu\mu$f

Mechanical:

Operating Position	Vertical, either end up
Maximum Overall Length (Excluding flexible leads)	7-1/8"
Maximum Diameter	4-11/16"
Terminal Connections	See *Dimensional Outline*
Radiator	Integral part of tube
Weight	6-1/4 lbs.

Thermal:

Air Flow:

Through Radiator—The specified flow of incoming air at a temperature of 45° C for various plate dissipations, as indicated in the tabulation below, should be delivered by a blower through the radiator before and during the application of any voltages. Filament power, plate power, and air may be removed simultaneously.

Percentage of Max. Rated Plate Dissipation for Each Class of Service	100	80	60	per cent
Minimum Air Flow	300	214	125	cfm
Static Pressure	2.9	1.47	0.58	in. of water

To Header and Filament Seals . . . . 10 min. *cfm*

The specified air flow from a 1"-diameter nozzle should be directed into the filament header before and during the application of any voltages in order to limit the temperature of the filament seals and the grid seal to their maximum value.

Incoming Air Temperature	45 max.	°C
Radiator Temperature (Measured on the core at end away from incoming air)	180 max.	°C
Bulb Temperature (At hottest part)	180 max.	°C
Seal Temperature:		
Filament, grid, and plate	180 max.	°C

AF POWER AMPLIFIER & MODULATOR — Class B

Maximum CCS[a] Ratings, *Absolute-Maximum Values:*[b]

DC PLATE VOLTAGE	6200 max.	volts
MAX.-SIGNAL DC PLATE CURRENT[c]	1.5 max.	amp
MAX.-SIGNAL PLATE INPUT[c]	8700 max.	watts
PLATE DISSIPATION[c]	4000 max.	watts

Typical Operation:

	Values are for 2 tubes	
DC Plate Voltage	4700	volts
DC Grid Voltage	-200	volts
Peak AF Grid-to-Grid Voltage	900	volts
Zero-Signal DC Plate Current	0.3	amp
Max.-Signal DC Plate Current	2.8	amp
Effective Load Resistance (Plate to plate)	3640	ohms
Max.-Signal Driving Power (Approx.)	195	watts
Max.-Signal Power Output (Approx.)	8800	watts

RF POWER AMPLIFIER — Class B Television Service

Synchronizing-level conditions per tube unless otherwise specified. At Frequency of 54 to 215 Mc.

Maximum CCS[a] Ratings, *Absolute-Maximum Values:*[b]

DC PLATE VOLTAGE	4500 max.	volts
DC PLATE CURRENT	2.0 max.	amp
DC GRID CURRENT (Pedestal level)	0.325 max.	amp
PLATE INPUT	9000 max.	watts
PLATE DISSIPATION	4000 max.	watts

Typical Operation in Cathode-Drive Circuit:

Bandwidth[d] of	*10 Mc*	*8.5 Mc*	*6.0 Mc*	
DC Plate Voltage	3000	3200	4300	volts
DC Grid Voltage	-105	-110	-150	volts
Peak RF Grid Voltage:				
Synchronizing level	380	435	500	volts
Pedestal level	290	310	355	volts
DC Plate Current:				
Synchronizing level	1.8	1.8	2.0	amp
Pedestal level	1.36	1.35	1.5	amp
DC Grid Current:				
Synchronizing level	0.265	0.400	0.439	amp
Pedestal level	0.115	0.130	0.118	amp
Driving Power (Approx.):[e]				
Synchronizing level	625	770	983	watts
Power Output (Approx.):				
Synchronizing level	3150	4000	6350	watts
Pedestal level	1800	2300	3590	watts

GRID MODULATED RF POWER AMPLIFIER — Class C Television Service

Synchronizing-level conditions per tube unless otherwise specified. At Frequency of 54 to 216 Mc.

Maximum CCS[a] Ratings, *Absolute-Maximum Values:*[b]

DC PLATE VOLTAGE	3700 max.	volts
DC GRID VOLTAGE (White level)	-800 max.	volts
DC PLATE CURRENT	1.9 max.	amp
DC GRID CURRENT (Pedestal level)	0.225 max.	amp
PLATE INPUT	6500 max.	watts
PLATE DISSIPATION	4000 max.	watts

Typical Operation in Cathode-Drive Circuit:

	Bandwidth[d] of 8.5 Mc	
DC Plate Voltage	3200	volts
DC Grid Voltage:		
Synchronizing level	-110	volts
Pedestal level	-220	volts
White level	-520	volts
Peak RF Grid Voltage	435	volts
DC Plate Current:		
Synchronizing level	1.8	amp
Pedestal level	1.25	amp
DC Grid Current (Approx.):		
Synchronizing level	0.400	amp
Pedestal level	0.130	amp
Driving Power (Approx.):[e]		
Synchronizing level	770	watts
Power Output (Approx.):		
Synchronizing level	4000	watts
Pedestal level	2300	watts

PLATE MODULATED RF POWER AMPLIFIER — Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0. See Ratings VS Frequency Chart.

Maximum CCS[a] Ratings, *Absolute-Maximum Values:*[b]

DC PLATE VOLTAGE	5000 max.	volts
DC GRID VOLTAGE	-1000 max.	volts
DC PLATE CURRENT	1.0 max.	amp
DC GRID CURRENT	0.3 max.	amp
PLATE INPUT	5000 max.	watts
PLATE DISSIPATION	2700 max.	watts

Typical Operation in Grid-Drive Circuit:

	Up to 30 Mc	*At 110 Mc*	
DC Plate Voltage	4700	4000	volts
DC Grid Voltage	-400	-350	volts
From a grid resistor of	1425	1460	ohms
Peak RF Grid Voltage[f]	675	600	volts
DC Plate Current	0.96	0.93	amp
DC Grid Current (Approx.)	0.28	0.24	amp
Driving Power (Approx.)	170	130	watts
Power Output (Approx.)	3700	2800	watts

Typical Operation in Cathode-Drive Circuit:

DC Plate Voltage	4700	4000	volts
DC Grid Voltage	-400	-350	volts
From a grid resistor of	1425	1460	ohms
Peak RF Grid Voltage	675	600	volts
DC Plate Current	0.96	0.93	amp
DC Grid Current (Approx.)	0.28	0.24	amp
Driving Power (Approx.)[g]	720	600	watts
Power Output (Approx.)	4200	3200	watts

RF POWER AMPLIFIER & OSC. — Class C Telegraphy and RF POWER AMPLIFIER — Class C FM Telephony

See Ratings VS Frequency Chart

Maximum CCS[a] Ratings, *Absolute-Maximum Values:*[b]

DC PLATE VOLTAGE	6200 max.	volts
DC GRID VOLTAGE	-1000 max.	volts
DC PLATE CURRENT	1.4 max.	amp
DC GRID CURRENT	0.3 max.	amp
PLATE INPUT	8700 max.	watts
PLATE DISSIPATION	4000 max.	watts

Typical Operation in Grid-Drive Circuit:

	Up to 30 Mc	
DC Plate Voltage	6000	volts
DC Grid Voltage:		
From a fixed supply of	-550	volts
From a grid resistor of	1900	ohms
From a cathode resistor of	360	ohms
Peak RF Grid Voltage	875	volts
DC Plate Current	1.25	amp
DC Grid Current (Approx.)	0.290	amp
Driving Power (Approx.)	225	watts
Power Output (Approx.)	6000	watts

Typical Operation in Cathode-Drive Circuit:

	Up to 30 Mc	*At 110 Mc*	*At 220 Mc*	
DC Plate Voltage.	6000	5000	4300	volts
DC Grid Voltage:				
From a fixed supply of. .	-550	-1000	-200	volts
From a grid resistor of .	1900	4100	807	ohms
From a cathode resistor of.	360	740	134	ohms
Peak RF Grid Voltage. . . .	875	1350	432	volts
DC Plate Current.	1.25	1.1	1.25	amp
DC Grid Current (Approx.) .	0.290	0.245	0.25	amp
Driving Power (Approx.) . .	1225	1680	542	watts
Power Output (Approx.). . .	7000	5500	4000	watts

SELF-RECTIFYING OSCILLATOR or AMPLIFIER — Class C

See Ratings VS Frequency Chart

Maximum CCS[a] Ratings, *Absolute-Maximum Values:*[b]

AC PLATE VOLTAGE (RMS).	7000 max.	volts
DC GRID VOLTAGE	-300 max.	volts
DC PLATE CURRENT.	0.635 max.	amp
DC GRID CURRENT	0.135 max.	amp
PLATE INPUT[h].	4900 max.	watts
PLATE DISSIPATION	4000 max.	watts

Typical Operation:

AC Plate Voltage (RMS).	6600	volts
DC Grid Voltage	-127	volts
DC Plate Current.	0.625	amp
DC Grid Current (Approx.)	0.105	amp
Driving Power (Approx.)[j].	60	watts
Power Output (Approx.).	3350	watts

AMPLIFIER or OSCILLATOR — Class C

With separate, rectified, unfiltered, single-phase, full-wave plate supply. See Ratings VS Frequency Chart.

Maximum CCS[a] Ratings, *Absolute-Maximum Values:*[b]

DC PLATE VOLTAGE.	5600 max.	volts
DC GRID VOLTAGE	-600 max.	volts
DC PLATE CURRENT.	1.25 max.	amp
DC GRID CURRENT	0.270 max.	amp
PLATE INPUT[k].	8600 max.	watts
PLATE DISSIPATION	4000 max.	watts

Typical Operation:

DC Plate Voltage.	5000	volts
DC Grid Voltage	-260	volts
DC Plate Current.	1.2	amp
DC Grid Current (Approx.)	0.260	amp
Driving Power (Approx.)[m].	150	watts
Power Output (Approx.).	5650	watts

[a] Continuous Commercial Service.

[b] The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices. *Absolute-Maximum Ratings* are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions and variations in device characteristics.

RATINGS vs FREQUENCY

FREQUENCY	30	110	220		Mc
MAX. PERMISSIBLE PERCENTAGE OF MAX. RATED PLATE VOLTAGE AND PLATE INPUT:					
Class B Television Service	Full Ratings — 54 to 216 Mc				
Class C Television Service	Full Ratings — 54 to 216 Mc				
Class C Telephony, Plate-Modulated	100	84	72		per cent
Class C Telegraphy and FM Telephony	100	84	72		per cent
Class C Amplifier or Osc., Self-Rectifying	100	84	72		per cent
Class C Amplifier or Osc. with Separate, Rectified, Unfiltered Plate Supply	100	84	72		per cent
MAX. PERMISSIBLE PERCENTAGE OF MAX. RATED DC GRID VOLTAGE AND DC GRID CURRENT:					
Class B Television Service	Full Ratings — 54 to 216 Mc				
Class C Television Service	Full Ratings — 54 to 216 Mc				
			Volt.	*Cur.*	
Class C Telephony, Plate-Modulated	100	100	60	83	per cent
Class C Telegraphy, and FM Telephony	100	100	60	83	per cent
Class C Amplifier or Osc., Self Rectifying	100	100	60	83	per cent
Class C Amplifier or Osc. with Separate, Rectified, Unfiltered Plate Supply	100	100	60	83	per cent

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Filament Current.	1	27	31	amp
Amplification Factor.	1,2	25	33	
Grid-Plate Capacitance.	-	16.5	20.5	μμf
Grid-Filament Capacitance	-	15.5	22.5	μμf
Plate-Filament Capacitance. . . .	-	0.38	0.62	μμf
Grid Voltage.	1,3	-125	-190	volts
Plate Voltage	1,4	1350	1750	volts
Plate Voltage	1,5	2600	3400	volts
Peak Cathode Current.	6	10	-	amp
Useful Power Output	1,7	3	-	kw

Note 1: With 12.6 volts rms on filament.

Note 2: With dc grid voltage of -25 volts measured from center tap of filament supply, and dc plate voltage adjusted to give dc plate current of 0.5 ampere.

Note 3: With dc plate voltage of 4000 volts, and dc grid voltage adjusted to give dc plate current of 0.05 ampere.

Note 4: With dc grid voltage of 0 volts measured from center tap of filament supply, and dc plate voltage adjusted to give dc plate current of 0.5 ampere.

Note 5: With dc grid voltage of -50 volts measured from center tap of filament supply, and dc plate voltage adjusted to give dc plate current of 0.5 ampere.

Note 6: Designers should limit the maximum useable cathode current (plate current and grid current) to this value under any condition of operation.

Note 7: In a self-excited, coaxial, oscillator circuit and with dc plate voltage of 5000 volts, dc plate current of 1.1 amperes, grid resistor of 1500 ± 10% ohms, dc grid current of 0.250 to 0.300 ampere, and frequency of 110 Mc.

[c] Averaged over any audio-frequency cycle of sine-wave form.

[d] Computed between half-power points in a single-tuned circuit and based on tube output capacitance only.

[e] The driver stage is required to supply tube losses and rf circuit losses. It should be designed to provide an excess of power above the indicated values to take care of variations in line voltage, in components, in initial tube characteristics, and in tube characteristics during life.

[f] Driver modulated approximately 30%.

[g] Carrier power of driver modulated 100%.

[h] Plate input is 1.11 times the product of the ac voltage (rms) and the dc plate current.

[j] From a self-rectified driver.

[k] Plate input is 1.23 times the product of the dc plate voltage and the dc plate current.

[m] From a driver with a rectified, unfiltered, single-phase, full-wave plate supply.

GENERAL CONSIDERATIONS

Ratings

The maximum radiator temperature of 180° C is a tube rating and is to be observed in the same manner as other ratings. The temperature of the radiator should be measured on the core at the end away from the incoming air. The temperature may be measured either with a thermocouple or with temperature-sensitive paint such as Tempilaq. The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, New York, in the form of liquid and stick.

Similarly, the maximum temperature of 180° C for the bulb as well as for the filament, grid, and plate seals is to be observed in the same manner as other ratings.

Handling

Care should be taken to protect the 5762-A from rough handling that would damage the metal-to-glass seals or other parts. Each tube is suspended within its shipping container so that it will not come in contact with the sides during shipment. The tube should be stored in the container with the filament end up and should be protected from moisture and extreme temperature changes.

Cleaning

It is recommended that the 5762-A be tested upon receipt in the equipment in which it is to be used. Before the tube is placed in operation, remove any foreign material adhering to it.

Tube cleanliness is an important consideration. As with other high-voltage equipment, it is essential that external parts of the 5762-A be kept free from accumulated dirt and moisture to minimize surface leakage and the possibility of corona and external arc-over. Make it a regular practice to wipe dirt from the external parts of the tube as frequently as necessary to keep the tube clean.

MECHANICAL CONSIDERATIONS

Mounting

The 5762-A requires a clamp support for the radiator (plate connection), a flexible connector for the grid-terminal flange, and three connectors for the filament leads. The tube should be supported in a vertical position with either end up or down. The entire weight of the tube must be supported by the clamp for the radiator. If the tube is subjected in service to considerable vibration, it is advisable to support the mounting by means of a spring suspension. The installation of all wires and connections must be made so that they will not be close to or touch the glass parts.

Connections

Connections to the filament and grid terminals must be kept flexible in order not to put strain on the glass-to-metal seals. None of the terminals should be used to support circuit parts.

Because of the relatively large high-frequency currents carried by the grid and plate terminals, heavy conductors should be used to make the circuit connections.

COOLING CONSIDERATIONS

System

Cooling of the 5762-A is accomplished by passing a stream of clean air through the radiator toward the filament end, and by directing a stream of air into the filament header. A suitable air filter is required in the air supply for the radiator. Care should be given to cleaning or replacing the filter at intervals in order that accumulated dirt will not obstruct the required flow of air through the radiator. The required air flow through the radiator for various plate dissipations is shown in Fig. 1. In using these curves for determining the cooling requirements of the tube as a plate-modulated rf power amplifier, it should be remembered that 100% sine-wave modulation causes a 50% increase in the plate dissipation above that obtained under carrier conditions. The header and filament seals are cooled by air flow of not less than 10 cubic feet per minute from a nozzle about 1 inch in diameter into the header.

Precautions

The cooling system should be properly installed to insure safe operation of the tube under all conditions and for this reason should be electrically interconnected with the filament and plate power supplies. This arrangement is necessary to make sure that the tube is supplied with air before any voltages are applied. Air pressure interlocks which open the power transformer primaries are desirable for protecting the tube when the air flow is insufficient or ceases.

ELECTRICAL CONSIDERATIONS

Filament

The filament of the 5762-A is of the thoriated-tungsten type. Under normal full-load conditions, the filament should be maintained at the rated voltage within ± 5%; with light loads, reduction of the filament voltage by as much as 5%

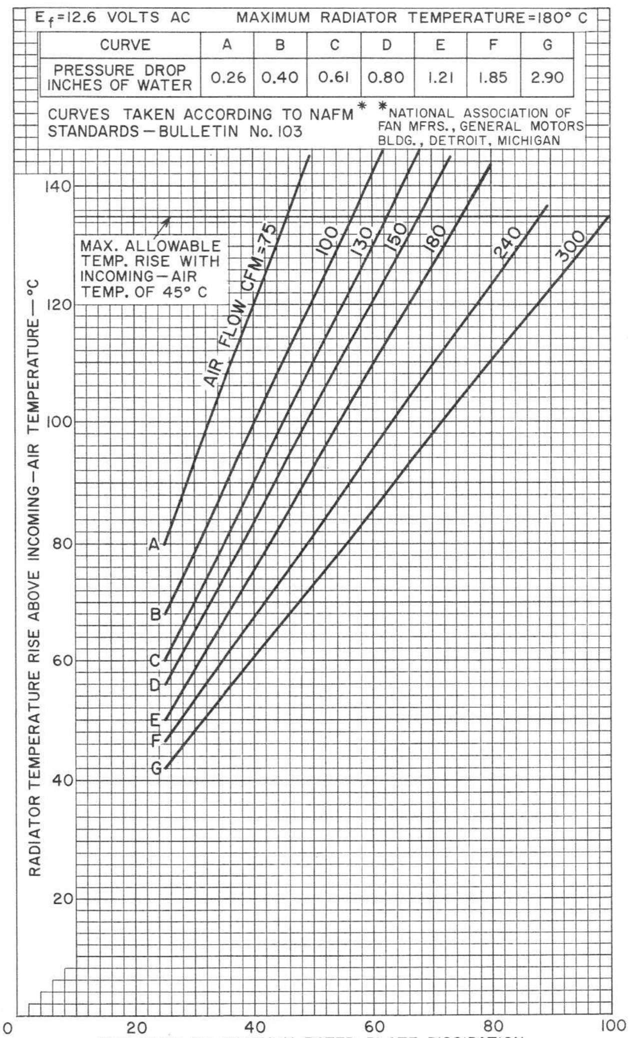


Fig. 1 - Typical Cooling Requirements for Type 5762-A.

is permissible. In the latter case, care must be taken that the reduction of the filament voltage and, therefore, of emission is not so great that the peak current requirements cannot be met. In intermittent service where the standby periods are no longer than 15 minutes, it is recommended that the filament voltage be reduced to 80% of normal during standbys; for longer periods, the filament voltage should be turned off.

The filament is center-tapped in order to minimize the effect of filament lead inductance, and not to permit operation of the two sections in parallel. At the higher frequencies, all three filament leads should be connected in parallel by means of rf bypass capacitors. Any one of these three leads may then be used as the rf return to the filament.

Having a maximum value of starting current about 6 times higher than the normal operating

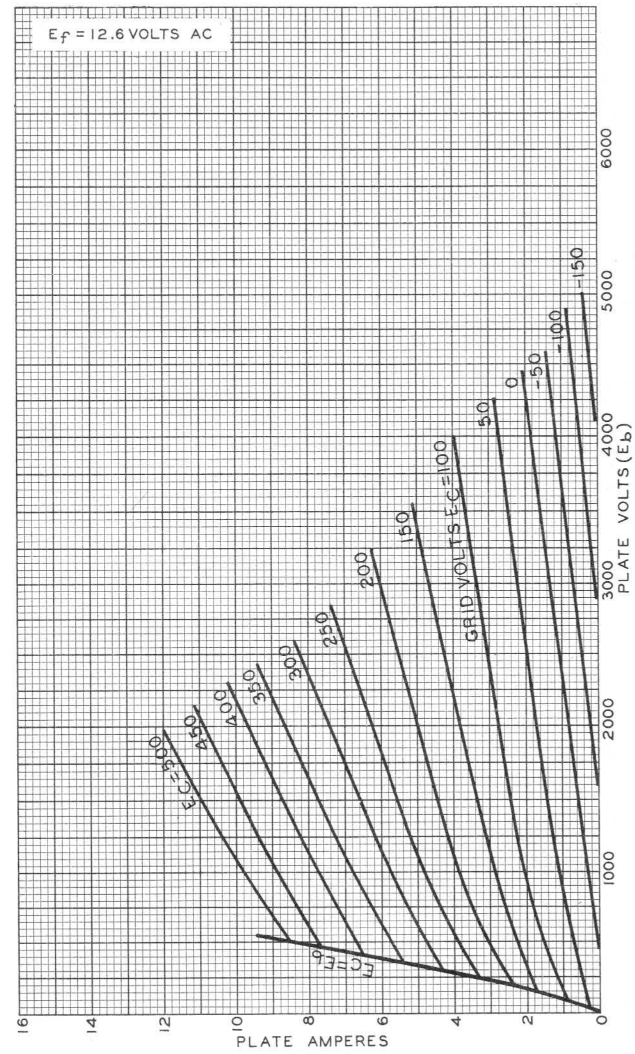


Fig. 2 - Average Plate Characteristics of Type 5762-A.

value, the filament can generally be operated from commercial transformers without a filament starter. Such transformers usually have adequate secondary impedance to hold the starting current below the maximum value of 175 amperes. If, however, the starting current should exceed, even momentarily, the value of 175 amperes, some means of limiting it will be required. Usually, a small increase in the resistance of the transformer-secondary circuit supplying the filament will be all that is required. Increasing the lead lengths between secondary and filament terminals is a convenient method of providing the desired increase in circuit resistance.

Overheating of the 5762-A by severe overload may decrease the filament emission. The filament activity can sometimes be restored by operating the filament at rated voltage for 10 minutes or more with no voltage on the plate or grid. This cation of plate voltage before the filament has reached normal operating temperature.

A protective device, such as a high-voltage fuse, should be used to protect the plate against overloads. It should remove the high voltage when the average value of plate current reaches a value of 50% above normal.

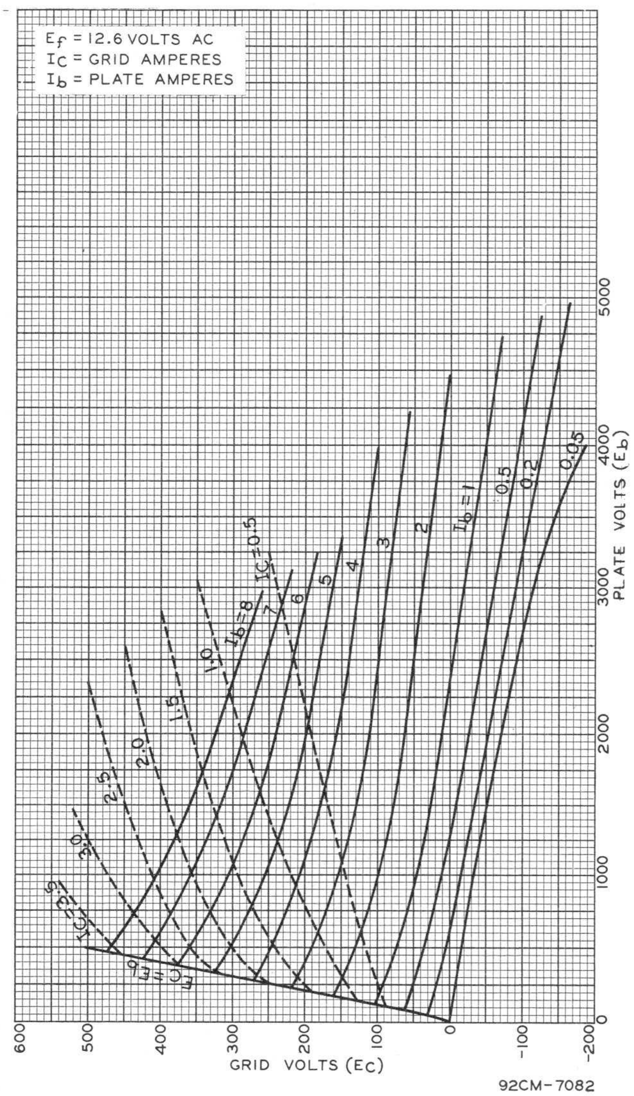


Fig. 3 - Average Constant-Current Characteristics of Type 5762-A.

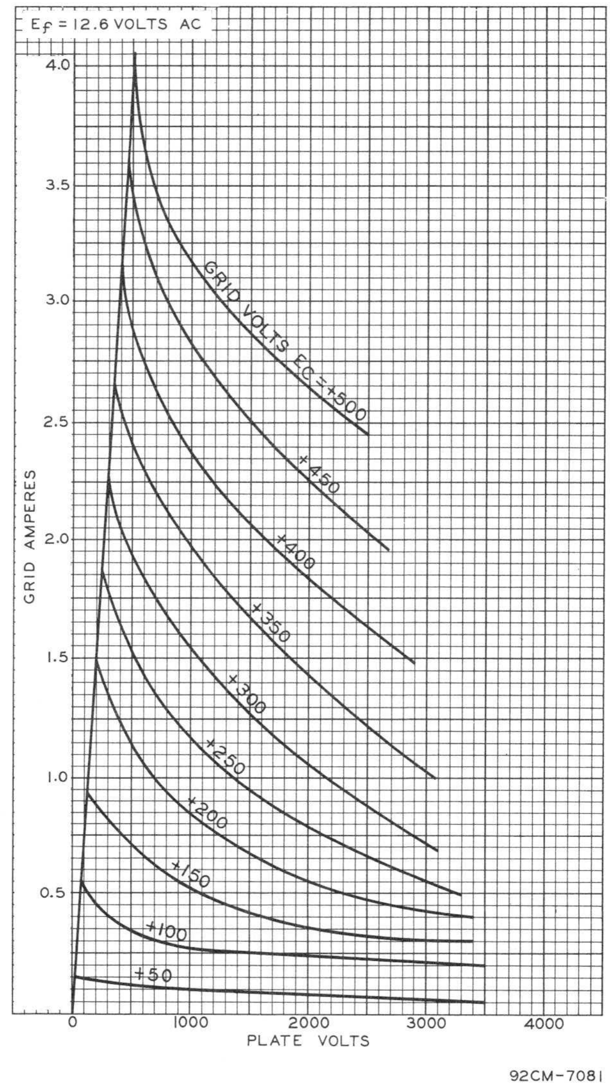


Fig. 4 - Typical Grid Characteristics of Type 5762-A.

process may be accelerated by raising the filament voltage to 15 volts (not higher) for a few minutes.

Protection Circuits

The rated plate voltage of this tube is extremely dangerous. Great care should be taken during the adjustment of circuits, especially when exposed parts are at high potential.

The plate circuit should be provided with a time-delay relay which will prevent the appli-

Circuit Requirements

In class B af modulator service, the 5762-A should be operated with grid bias obtained from a battery or other source of dc voltage having good regulation. It should not be obtained from a high-resistance source such as a grid resistor, nor from a rectifier unless the rectifier has exceptionally good voltage regulation. Each grid circuit should be provided with a separate bias adjustment to balance the grid and plate currents.

In class B television service, the bias requirements are the same as those indicated under class B af modulator service.

In class C television service, the 5762-A is supplied with unmodulated rf grid voltage and with a video-modulated grid voltage.

In plate-modulated class C rf power amplifier service, the 5762-A should be supplied with bias from a grid resistor, or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor. The cathode resistor should be bypassed for both audio and radio frequencies. The combination method of grid resistor and fixed supply has the advantage of not only protecting the tube from damage through loss of excitation but also of minimizing distortion by bias-supply compensation. Grid-bias voltage is not particularly critical so that correct adjustment may be obtained with values differing widely from the calculated values.

In cathode-drive plate-modulated class C telephony service, the 5762-A can be modulated 100 per cent if the rf driver stage is also modulated 100 per cent simultaneously. Care should be taken to insure that the driver-modulation and the amplifier-modulation voltages are exactly in phase. In such service, the 5762-A requires increased driving power, but increased power output is obtained as shown in the tabulated data.

In class C rf telegraphy service, the 5762-A may be supplied with bias by any convenient method. When the tube is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed bias must be used to limit the plate current and, therefore, the plate dissipation to a safe value. If the 5762-A is operated at a plate voltage of 5000 volts, a fixed bias of at least -190 volts should be used.

In class C FM telephony service, the 5762-A may be supplied with bias by any convenient method. This type of service is similar to conventional class C rf telegraphy service.

In class C service primarily for industrial applications, the 5762-A can be operated as a self-rectifying oscillator or amplifier, or as an amplifier or oscillator with a separate, rectified, single-phase, full-wave plate supply without a filter. In such service, the 5762-A can be biased by any convenient method, but the use of a grid resistor is preferred because the bias is automatically adjusted as the load on the circuit varies. In those applications where grid current and grid voltage may vary widely because of fluctuating loads, it is important to design equipment so that the maximum grid-current and grid-voltage ratings are never exceeded for any load. An approximate rule is to adjust the grid-current and grid-voltage values at full load to one-half of the corresponding maximum values. This operating condition permits grid-current and grid-voltage values to rise from zero to twice their full-load values, and usually provides adequate leeway.

In grid-drive circuits, the grid current and driving power required to obtain the desired power output will vary with the plate loading. If the plate circuit presents a relatively low resistance to the tube, the desired output can be obtained with relatively low grid current and driving power, but plate-circuit efficiency is sacrificed. Conversely, if the tube operates into a relatively high load resistance, relatively high grid current and driving power are required to obtain the desired output and the plate circuit efficiently will be high. In practice, a compromise must be made between these extremes. The typical operating conditions given in the tabulated data represent compromise conditions which give good plate-circuit efficiency with reasonable driving power.

In order to permit considerable range of adjustment, and also to provide for losses in the grid circuit and the coupling circuits, the driver stage should have considerably more output capability than the typical driving power shown in the tabulated data. This recommendation is particularly important near the maximum rated frequency where there are other losses of driving power, such as those caused by radiation and transit-time effects.

In cathode-drive circuits, there is a further increase in required driving power due to the fact that the grid-driving voltage and the developed rf plate voltage act in series to supply the load circuit. The increased driving power is not lost because it appears as output from the cathode-drive stage. If the driving voltage and grid current are increased, the output will always increase. Such is not the case in a grid-drive circuit where a saturation effect takes place, i.e., above a certain value of driving voltage and current, the output increases very slowly and may even decrease. It is important to recognize this difference and not try to saturate a cathode-drive stage because the rated maximum grid current may easily be exceeded.

Care must be exercised to shield completely the filament-grid circuit from the grid-plate circuit when the 5762-A is used in cathode-drive circuits at the higher frequencies.

In tuning a cathode-drive rf amplifier, it must be remembered that variations in the load on the output stage will produce corresponding variations in the load on the driving stage. This effect will be noticed by the simultaneous increase in plate currents of both the output and driving stages.

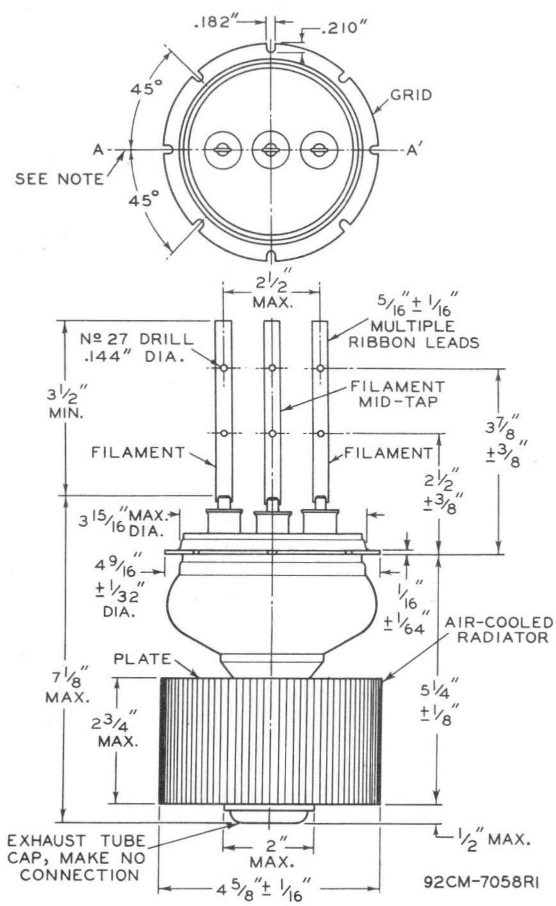
Push-pull or parallel circuit arrangements may be used when more radio-frequency power is required than can be obtained from a single tube.

Two tubes in parallel or push-pull will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage necessary to drive a single tube. With either connection, the driving power required is approximately twice that for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more tubes are used in the circuit, precautions should be taken to balance the plate currents.

REFERENCE

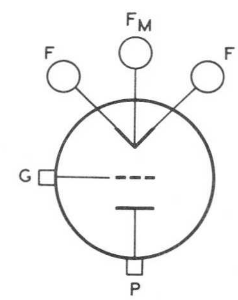
E. E. Spitzer, *"Grounded-Grid Power Amplifiers"*, Electronics, Vol.19, No.4, pp.138-141 (April, 1946).

DIMENSIONAL OUTLINE



NOTE: PLANE OF FILAMENT LEADS WILL NOT DEVIATE MORE THAN 3-1/2° FROM PLANE PASSING THROUGH AA' NORMAL TO GRID FLANGE.

TERMINAL CONNECTIONS



F : FILAMENT
F_M: FILAMENT MID-TAP
G : GRID FLANGE
P : RADIATOR-COOLED PLATE

5820-A

IMAGE ORTHICON

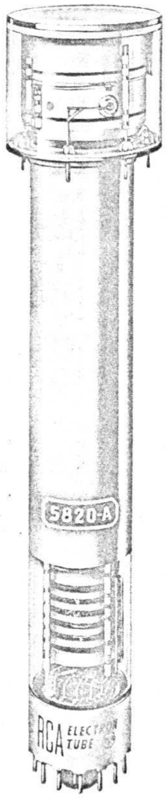
Magnetic Focus
Magnetic Deflection

For Outdoor and Studio Pickup
High Sensitivity

3"-Diameter Bulb
15.20" Length

The 5820-A is unilaterally interchangeable with the 5820.

RCA-5820-A is an image-orthicon type of television camera tube intended for both outdoor and studio pickup. It features extremely tight limits on such important performance characteristics as signal-to-noise ratio, resolution, sensitivity, and uniformity of sensitivity and background. The 5820-A is capable of providing pictures of very high quality and also of providing stable operation over a wide range of incident light levels on the object.



Stable performance is obtained with incident light levels on the object ranging from bright sunlight (several thousand footcandles) to a deep shadow (one footcandle or less). The sensitivity of the 5820-A is equivalent to photographic film having an ASA exposure index of 8000. Commercially acceptable pictures can be obtained at incident light levels greater than about 10 footcandles with appropriate setting of the camera lens stops. The 5820-A has an S-10 spectral response which approaches the response of the eye.

The photocathode utilized in the 5820-A is characterized by a spectral response having high blue sensitivity, high green sensitivity, good red sensitivity, and practically no infrared sensitivity. This latter characteristic of the response prevents any color-masking by infrared, and thus permits gray-scale rendition of colors in nearly their true tonal gradation.

Under proper operating conditions, the 5820-A has light transfer characteristics which do not require the use of gamma-correction circuits to provide normal tone rendition in black-and-white pictures on the picture-tube screen.

DATA

General:

Heater, for Unipotential Cathode:
  Voltage (AC or DC) . . . . 6.3 ± 10% volts
  Current . . . . 0.6 ampere
Direct Interelectrode Capacitance:
  Anode to all other electrodes . . 12 pf ←
Spectral Response S-10
Wavelength of Maximum Response. . . 4500 ± 300 angstroms
Photocathode, Semitransparent:
  Rectangular Image (4 x 3 aspect ratio):
    Useful size of. . . . . 1.8" max. Diagonal
      Note: The size of the optical image focused on the photocathode should be adjusted so that its maximum diagonal does not exceed the specified value. The corresponding electron image on the target should have a size such that the corners of the rectangle just touch the target ring.
    Orientation of. . . . .Proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through center of faceplate and pin No.7 of the shoulder base.
Focusing Method . . . . Magnetic
Deflection Method . . . . Magnetic
Overall Length. . . . . 15.20" ± 0.25"
Greatest Diameter of Bulb . . . . 3.00" ± 0.06"
Shoulder Base . . . . Keyed Jumbo Annular 7-Pin
End Base. . Small-Shell Diheptal 14-Pin (JEDEC No.B14-45)
Operating Position. . . The tube should never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with the base up makes an angle of less than 20° with the vertical.
Weight (Approx.). . . . . 1 lb 6 oz
Minimum Deflecting-Coil Inside Diameter . . . . . 2-3/8"
Deflecting-Coil Length. . . . . 5"
Focusing-Coil Length. . . . . 10"
Alignment-Coil Length . . . . 15/16"
Photocathode Distance Inside End of
  Focusing Coil . . . . 1/2"

Contents

→ Indicates a change.

Maximum Ratings, ***Absolute-Maximum Values:***[a]

PHOTOCATHODE:		
Voltage	-550 max.	volts
Illumination	50 max.	fc
OPERATING TEMPERATURE:		
Of any part of bulb	50 max.	°C
Of bulb at large end of tube (Target section)	35 min.	°C
TEMPERATURE DIFFERENCE:		
Between target section and any part of bulb hotter than target section	5 max.	°C
GRID-NO.6 VOLTAGE	-550 max.	volts
TARGET VOLTAGE:		
Positive value	10 max.	volts
Negative value	10 max.	volts
GRID-NO.5 VOLTAGE	150 max.	volts
GRID-NO.4 VOLTAGE	300 max.	volts
GRID-NO.3 VOLTAGE	400 max.	volts
GRID-NO.2 & DYNODE-NO.1 VOLTAGE	350 max.	volts
GRID-NO.1 VOLTAGE:		
Negative-bias value	125 max.	volts
Positive-bias value	0 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	10 max.	volts
ANODE-SUPPLY VOLTAGE[b]	1350 max.	volts
VOLTAGE PER MULTIPLIER STAGE	350 max.	volts

Typical Operating Values:

Photocathode Voltage (Image Focus)	-400 to -540	volts
Grid-No.6 Voltage (Accelerator)—(Approx. 75% of photocathode voltage)	-300 to -405	volts
Target-Cutoff Voltage[c]	-3 to +1	volts
Grid-No.5 Voltage (Decelerator)	0 to 125	volts
Grid-No.4 Voltage (Beam Focus)	140 to 180	volts
Grid-No.3 Voltage[d]	225 to 330	volts
Grid-No.2 & Dynode-No.1 Voltage	300	volts
Grid-No.1 Voltage for Picture Cutoff	-45 to -115	volts
Dynode-No.2 Voltage	600	volts
Dynode-No.3 Voltage	800	volts
Dynode-No.4 Voltage	1000	volts
Dynode-No.5 Voltage	1200	volts
Anode Voltage	1250	volts
Minimum Peak-to-Peak Blanking Voltage	5	volts
Field Strength at Center of Focusing Coil[e]	75	gausses
Field Strenth of Alignment Coil	0 to 3	gausses

Performance Data:[f]

With conditions shown under Typical Operating Values and with camera lens set to bring the picture highlights one stop above the "knee" of the light transfer characteristic

	Min.	Average	Max.	
Cathode Radiant Sensitivity at 4500 angstroms	–	0.030	–	amp/watt
Luminous Sensitivity	30	60	–	μa/lumen
Anode Current (DC)	–	30	–	μa
Signal-Output Current (Peak to Peak)	3	8	24	μa
Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current for Bandwidth of 4.5 Mc.	35:1	40:1	–	
Photocathode Illumination at 2870° K Required to bring Picture Highlights One Stop above "Knee" of Light Transfer Characteristic	–	0.02	0.04	fc
Peak-to-Peak Response to Square-Wave Test Pattern of 400 TV Lines per Picture Height (Per cent of large-area black to large-area white)[g]	35	60	–	% ←
Uniformity:				
Ratio of Shading (Background) Signal to Highlight Signal	–	0.12	0.15	
Variation of Highlight Signal (Per cent of maximum highlight signal)[h]	–	20	25	%

→ Indicates a change.

a The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

b Dynode voltage values are shown under *Typical Operating Values.*

c Normal setting of target voltage is +2 volts from target cutoff. The target supply voltage should be adjustable from -3 to +5 volts.

d Adjust to give the most uniformly shaded picture near maximum signal.

e Direction of current should be such that a north-seeking pole is attracted to the image end of the focusing coil, with indicator located outside of and at the image end of the focusing coil.

f With 5820-A operated in properly adjusted RCA TK-31 camera.

g Measured with amplifier having flat frequency response.

h Variation of response over scanned area.

INTERCHANGEABILITY

The 5820-A is directly interchangeable with the 5820 in all existing cameras. The information shown on the following pages under *Set-Up Procedure, Operating Considerations, Camera-Design Considerations,* and *Principles of Operation* is identical with that recommended for the 5820.

SET-UP PROCEDURE

The *set-up procedure* for operating the 5820-A is as follows: After the tube has been inserted in its sockets and the voltages applied as indicated under *Typical Operation,* allow it to warm up for 1/4 to 1/2 hour with the camera lens capped. Uncap the lens momentarily while adjusting the grid-No.1 voltage to give a small amount of beam current. This procedure will prevent the mesh from being electrostatically pulled into contact with the glass disc. Make certain that the deflection circuits are functioning properly to cause the electron beam to scan the target.

Adjust the deflection circuits so that the beam will "overscan" the target, i.e., so that the area of the target scanned is greater than its sensitive area. This procedure during the warming-up period is recommended to prevent burning on the target a raster smaller than that used for on-the-air operation. Note that overscanning the target results in a smaller-than-normal picture on the monitor.

With the lens still capped and the target voltage set at approximately 2 volts negative, adjust the grid-No.1 voltage until noise or a rough-textured picture of dynode No.1 appears on the monitor. Then adjust the alignment-coil current so that the small white dynode spot does not move when the beam-focus control (grid No.4) is varied, but simply goes in and out of focus. During alignment of the beam, and also during operation of the tube, always keep the beam current as low as possible to give the best picture quality and to prevent excessive noise.

Next, uncap the lens and open the lens iris partially. Focus the camera on a test pattern. The target voltage is then advanced until a reproduction of the test pattern is just discernible on the monitor. This value of target voltage is known as the "target cutoff voltage". The target voltage should then be raised exactly 2 volts above the cutoff-voltage value, and the beam-current control adjusted to give just sufficient beam current to discharge the highlights.

Then adjust the lens to produce best optical focus, and the voltage on the photocathode as well as the voltage on grid No.4 to produce the sharpest picture.

At this point, attention should be given to the grid-No.5 and grid-No.3 voltage controls. Grid No.5 is used to control the landing of the beam on the target and consequently the uniformity of signal output. The grid-No.5 voltage control should be adjusted to produce a picture that has most uniform shading from center to edge with the lens iris opened sufficiently to permit operation with the highlights above the knee of the light transfer characteristic. The value of grid-No.5 voltage should be as high as possible consistent with uniform shading. Grid No.3 facilitates a more complete collection by dynode No.2 of the secondaries from dynode No.1. The grid-No.3 voltage control should be adjusted to produce the maximum signal output.

Now with a test pattern consisting of a straight line centered on the face of the 5820-A adjust the voltage on grid-No.6 along with the voltage on the photocathode to produce a sharply focused straight line on the monitor. Improper adjustment of the grid-No.6 voltage control will result in the straight-line pattern being reproduced with a slight S-shape.

The above adjustments constitute a rough set-up of the 5820-A. Final adjustments necessary for the 5820-A to produce the best possible picture are as follows: With the lens capped, realign the beam. Beam alignment is necessary after each change of the grid-No.5 voltage control and sometimes after each adjustment of the grid-No.3 voltage control.

The proper illumination level for camera operation should next be determined. Adjust the target voltage accurately to 2 volts above the target-cutoff value. Remove the lens cap and focus the camera on a test pattern. Open the lens iris just to the point where the highlights of the test pattern do not rise as fast as the low-lights when viewed on a video waveform oscilloscope.

Next, cap the lens and adjust the grid-No.3 voltage control so that the video signal when viewed on a video waveform oscilloscope has the flattest possible trace consistent with high signal output. This represents the black level of the picture.

The lens iris setting should then be noted, and the lens stop opened not more than one position beyond this point, unless extreme scene-contrast ranges necessitate opening the lens stop beyond this point.

The use of a higher value of target voltage than that recommended will shorten the life of the 5820-A. The target-voltage control should not be used as an operating control to match pictures from two different cameras. Matching of cameras should be accomplished by control of the lens iris openings.

Retention of a scene by the 5820-A sometimes called a "sticking picture", may be experienced if the 5820-A is allowed to remain focused on a stationary bright scene, or if it is focused on a bright scene before reaching operating temperature in the range from 35° to 45° C. Often the retained image will disappear in a few seconds, but sometimes it may persist for long periods before it completely disappears. A very persistent image can generally be removed by focusing the 5820-A on a clear white screen and allowing it to operate for a period of time with an illumination of about 1 footcandle on the photocathode.

To avoid retention of a scene, it is recommended that the 5820-A always be allowed to warm up in the camera for 1/4 to 1/2 hour with the lens iris closed and with a slight amount of beam current. Never allow the 5820-A to remain focused on a stationary bright scene, and never use more illumination than is necessary.

OPERATING CONSIDERATIONS

New 5820-A's should be placed in service immediately upon receipt. They should be operated for several hours before being set aside as spares.

Spare 5820-A's should be placed in service for several hours at least once a month in order to keep them free from traces of gas which may be liberated within the tube during prolonged storage.

Occasionally, a *white spot* which does not change in size when the beam-focus voltage is varied, may be observed in the center of the picture. Such a spot, especially if it is visible on the monitor with the camera lens capped, is probably an ion spot. If the spot begins to grow in size with continuous operation, the 5820-A should be removed from service at once, and returned for re-processing. Continued operation of an image orthicon with an ion spot will eventually damage the target permanently.

The *spectral response* of the 5820-A is shown in Fig.1.

The *operating temperature* of any part of the glass bulb should never exceed 50° C, and no part of the bulb at the large end of the tube (target section) should ever fall below 35° C during operation. The temperature of the target is essentially the same as that of the adjacent glass bulb and can, therefore, be determined by measuring the temperature of the glass bulb adjacent to the target. For best results, it is recommended that the temperature of the entire bulb be held between 35° and 45° C. Operation of too low a temperature will be characterized by the appearance of a rapidly disappearing "sticking picture" of opposite polarity from the original when the picture is moved. Operation at too high a temperature will cause loss of resolution and possibly permanent damage to the tube. Resolution is regained by waiting for the temperature to drop below 45° C. *No part of the bulb should run more than 5° C hotter than the target section to prevent cesium migration to the target.* Such migration will result in loss of resolution and in probable permanent damage to the tube. Like other photosensitive devices employing cesium, the 5820-A may show fluctuations in performance from time to time. Strict observance of the above recommendations with respect to operating temperature will not completely eliminate these variations but will greatly improve the stability of the characteristics during the life of the tube.

Full-size scanning of the target should always be used during on-the-air operation. Full-size scanning can be assured by first adjusting the deflection circuits to overscan the target sufficiently to cause the corners of the target to be visible in the picture, and then reducing the scanning until the corners just disappear. In this way, the maximum signal-to-noise ratio and maximum resolution can be obtained. Note that overscanning the target produces a smaller-than-normal picture on the monitor.

Underscanning the target, i.e., scanning an area of the target less than its sensitive area, should never be permitted. Underscanning produces a larger-than-normal picture on the monitor. If the target is underscanned for any length of time, a permanent change in target cutoff voltage of the underscanned area takes place with the result that the underscanned area thenceforth is visible in the picture when full-size scanning is restored.

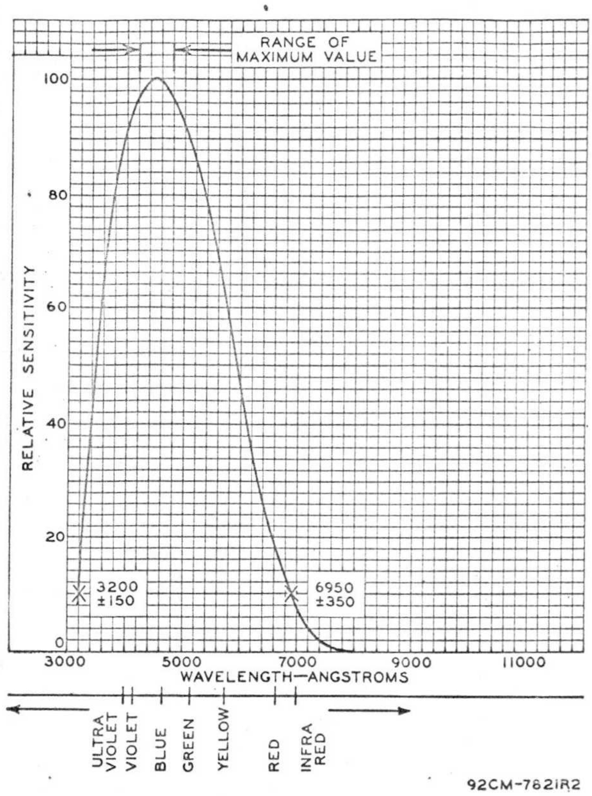


Fig. 1 - Spectral Sensitivity Characteristic of Type 5820-A which has S-10 Response. Curve is shown for Equal Values of Radiant Flux at All Wavelengths.

To utilize the *resolution capability* of the 5820-A in the horizontal direction with the standard scanning rate of 525 lines, it is necessary to use a video amplifier having a bandwidth of at least 6 megacycles.

Even with a wide-band amplifier, the resolution may be limited in the image section by "cross talk" caused by the scanning fields. Unless prevented by proper shielding from extending into the image section (see *Proper Shielding* under *Camera-Design Considerations*), these fields will cause the electron image on the target to move at scanning frequency. As a result, the picture will lack definition.

The *dynode aperture* appears as a small white spot near the center of the image of the dynode surface. The white spot is most evident when it falls within dark areas of the scene. Little defocusing of the beam is required to minimize the effect of dynode aperture when the scene is brightly illuminated, but in dark scenes, the effect of dynode aperture is a limiting item on resolution.

Dynamic focusing may be employed to give more uniform focus from center to edge of picture, and to eliminate dynode pattern or texture in low-light portions of a scene. Dynamic focusing is accomplished by applying to the beam-focus electrode (grid No.4) a voltage with parabolic waveform consisting of mixed horizontal and vertical scanning frequencies. The peaks of the parabolic waveform should be negative and coincident with those of the blanking signal. The dynamic-focusing voltage should have a peak-to-peak value of about 5 volts.

The *light transfer characteristics* of the 5820-A change for different illumination levels (see Reference 2). The basic light transfer characteristic of the 5820-A is shown in Fig.2. This curve is representative only for small-area highlights. For larger-area highlights, the bend or "knee" is not quite as abrupt as shown in Fig.2.

Sensitivity and Illumination: The image orthicon is an ultra-sensitive device exceeding in relative sensitivity most high-speed photographic film. When related to photographic film and compared at shutter speeds of 1/60 second which is the field rate of the television system, the 5820-A with proper illumination will have an equivalent ASA exposure index of 8000. This equivalent film-speed rating can be used in conjunction with a photographic exposure meter to determine the approximate light level or lens-stop setting necessary for operating the 5820-A.

The illumination on the photocathode of the 5820-A in relation to the scene illumination, can be determined by the following relationship:

$$I_s = \frac{4f^2 \, I_{pc} \, (m+1)^2}{TR}$$

where

I_s = scene illumination in footcandles
f = f-number of lens
I_{pc} = photocathode illumination in footcandles
m = linear magnification from scene to target
T = total transmission of lens
R = reflectance of principal subject in scene

Except for very close shots, the linear magnification (m) from scene to target may be neglected.

For example, assume that the lens is f:11 having a transmission (T) of 80%, that the photocathode illumination is 0.020 footcandle, and that the scene to be televised has a highlight reflectance (R) of 75%.
Then,

$$I_s = \frac{4 \times 11^2 \times 0.020}{0.8 \times 0.75} = 16 \text{ footcandles}$$

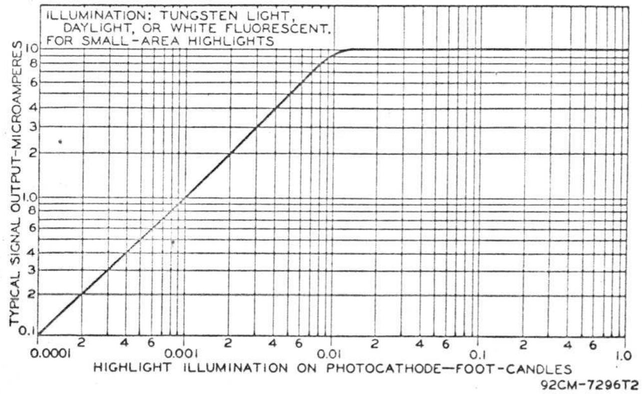


Fig. 2 - Basic Light Transfer Characteristic of Type 5820-A.

The exact illumination for each 5820-A as finally set up on the scene should be determined by observing the video waveform on an oscilloscope. First adjust the lens setting of each camera to that level of light necessary to reach the knee of the light transfer characteristic. The camera lens is then normally set to bring picture highlights one stop above the knee of the transfer characteristic.

For very high illumination or for individual tubes with exceptionally high photocathode sensitivity, it may not be possible to stop the lens down far enough to reduce the highlight illumination on the photocathode to a value near the knee of the transfer characteristic. When such a condition is encountered, the use of a Wratten neutral filter selected to give the required reduction in illumination is recommended. Ordinarily, two filters—one having 10% transmission and the other 20%—will give sufficient choice. Such filters with lens-adapter rings can be obtained at photographic-supply stores.

The low illumination level needed on the photocathode of the 5820-A makes it necessary that no stray light from without or within the camera falls on the face of the tube.

CAMERA-DESIGN CONSIDERATIONS

The 5820-A has two complementary guides for inserting the tube correctly in the annular socket, i.e., the large pin (No.7) on the annular base, and the white radial line on the face of the bulb. The annular socket should be positioned so that the key pin (No.7) of the annular base is in a vertical plane through the common axis of the deflecting-coil assembly and the focusing coil assembly, and is at the bottom of the pin circle of the annular base.

The 5820-A is installed by inserting the diheptal-base end of the tube through the coil assembly and then turning the tube until the annular-base pins, keyed by pin No.7, can be inserted in the annular socket. Proper insertion aligns the white radial line on the face with center of the key-pin hole in the annular socket. The diheptal socket is then put on the 14-pin base.

A *mask* having a diagonal or diameter of 1.8 inches should always be used on the photocathode to set limits for the maximum size of scan, and to reduce the amount of light reaching unused parts of the photocathode.

The *optical system* used with the 5820-A should be designed according to basic optical principles and should incorporate an iris to control the amount of light entering the television camera lens. The entire optical system should have all inside surfaces finished in mat black to prevent internal reflections from reaching the photocathode. Under almost all conditions, the use of a lens shade is beneficial.

Proper shielding of the image section can be provided by wrapping around the outside of the focusing coil directly over the center of the deflecting coils a triple layer of Mumetal strip 0.006" thick and 5" wide, or equivalent. Then, wrap another triple layer of Mumetal strip 0.006" thick and 3" wide around the focusing coil directly over the image section of the 5820-A. Additional shielding is provided by fitting the inside of the focusing coil directly over the image section with a copper cylinder having a length of approximately 2-1/4" and a wall thickness of 1/32". The Mumetal shielding effectively shunts the field-rate deflection field, while the copper cylinder shields the higher frequency line-scanning field from the electron path in the image section. Unless proper shielding is provided, "cross talk" from the deflecting yoke into the image section will result in loss of picture sharpness.

A *blanking signal* should be supplied to the target to prevent the electron beam from striking the target during the return portions of the horizontal and vertical deflecting cycles. Unless this is done, the camera-tube return lines will appear in the received picture.

The blanking signal is a series of negative voltage pulses. The voltage between pulses must be constant to prevent fluctuation of the target voltage. During the blanking periods, the full beam current without video-signal modulation is returned to the multiplier and its multiplied output flows through the load resistance. Excessive amounts of blanking voltage applied to the target will impair resolution, since during retrace the target is out of focus to the continuously flowing photocathode current. A desirable amount of target blanking is 6 volts peak to peak.

Shading may be required even with optimum adjustment of voltage on grid No.3 in order to obtain a uniformly shaded picture. Sawtooth and parabolic waveforms of adjustable amplitude and polarity at both the vertical- and horizontal-scanning frequency should be provided for insertion in the video amplifier to aid in obtaining a flat background. The shading signal should be introduced in the amplifier after clamping is performed, since clamping circuits will remove the vertical-frequency shading component if added previous to the clamp-circuit location.

Failure of scanning even for a few minutes when light is incident on the photocathode may permanently damage the surface of the target. The damaged area shows up as a spot or line in the picture during subsequent operation.

To avoid damaging the 5820-A during scanning failure, provision should be made to prevent automatically the scanning beam from reaching the target. The scanning beam can be prevented from reaching the target by (1) cutting off the scanning beam, or (2) making the target sufficiently negative. The scanning beam can be cut off by a relay which applies -115 to -125 volts bias to grid No.1. The target can be made sufficiently negative by a relay which applies a bias of -10 volts to it. Either relay is actuated by a tube which is controlled by a portion of the scanning pulse voltage developed across either the horizontal or the vertical deflecting coils, or both. It is important to insure that in the event of failure of either the horizontal scanning pulse or the vertical scanning pulse, the circuitry should be capable of actuating the protection relay.

PRINCIPLES OF OPERATION

The 5820-A has three sections—an image section, a scanning section, and a multiplier section.

Image Section

The image section contains a semitransparent photocathode on the inside of the faceplate, a grid to provide an electrostatic accelerating field, and a target which consists of a thin glass disc with a fine mesh screen very closely spaced to it on the photocathode side. Focusing is accomplished by means of a magnetic field produced by an external coil, and by varying the photocathode voltage.

Light from the scene being televised is picked up by an optical lens system and focused on the photocathode which emits electrons from each illuminated area in proportion to the intensity of the light striking the area. The streams of electrons are focused on the target by the magnetic and accelerating fields.

On striking the target, the electrons cause secondary electrons to be emitted by the glass. The secondaries thus emitted are collected by the adjacent mesh screen which is held at a definite potential of about 2 volts with respect to target-voltage cutoff. Therefore, the potential of the glass disc is limited for all values of light and stable operation is achieved. Emission of the secondaries leaves on the photocathode side of the glass a pattern of positive charges which corresponds with the pattern of light from the scene being televised. Because of the thinness of the glass, the charges set up a similar potential pattern on the opposite or scanned side of the glass.

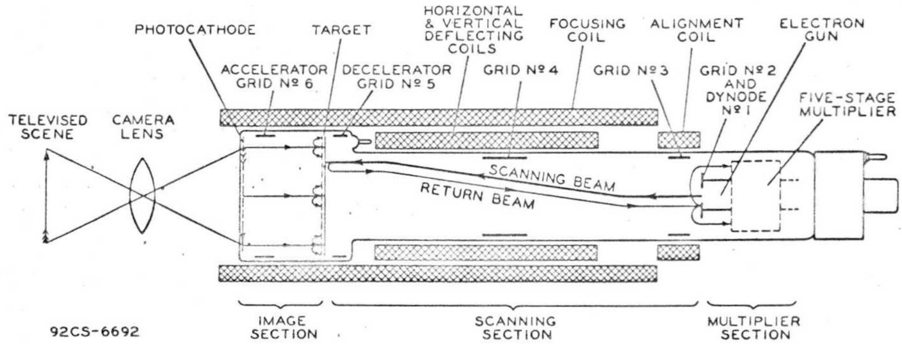


Fig. 3 - Schematic Arrangement of Type 5820-A.

Scanning Section

The opposite side of the glass is scanned by a low-velocity electron beam produced by the electron gun in the scanning section. This gun contains a thermionic cathode, a control grid (grid No.1), and an accelerating grid (grid No.2). The beam is focused at the target by the magnetic field of an external focusing coil and the electrostatic field of grid No.4.

Grid No.5 serves to adjust the shape of the decelerating field between grid No.4 and the target in order to obtain uniform landing of electrons over the entire target area. The electrons stop their forward motion at the surface of the glass and are turned back and focused into a five-stage signal multiplier, except when they approach the positively charged portions of the pattern on the glass. When this condition occurs, they are deposited from the scanning beam in quantities sufficient to neutralize the potential pattern on the glass. Such deposition leaves the glass with a negative charge on the scanned side and a positive charge on the photocathode side. These charges will neutralize each other by conductivity through the glass in less than the time of one frame.

Alignment of the beam from the gun is accomplished by a transverse magnetic field produced by an external coil located at the gun end of the focusing coil.

Deflection of the beam is accomplished by transverse magnetic fields produced by external deflecting coils.

The electrons turned back at the target form the return beam which has been amplitude modulated by absorption of electrons at the target in accord with the charge pattern whose more positive areas correspond to the highlights of the televised scene.

Multiplier Section

The return beam is directed to the first dynode of a five-stage electrostatically focused multiplier. This utilizes the phenomenon of secondary emission to amplify the modulated beam current more than 500 times. The electrons in the beam impinging on the first-dynode surface produce many other electrons. These secondary electrons are then directed to the second dynode and knock out more new electrons. Grid No.3 facilitates a more complete collection by dynode No.2 of the secondaries from dynode No.1. The multiplying process is repeated in each successive stage, with an ever-increasing stream of electrons until those emitted from dynode No.5 are collected by the anode and constitute the current utilized in the output circuit.

The signal-to-noise ratio of the output signal from the 5820-A is high. The gain of the multiplier is such as to raise the output signal sufficiently above the noise level of the video-amplifier stages so that they contribute no noise to the final video signal. The signal-to-noise ratio of the video signal, therefore, is determined only by the random variations of the modulated electron beam.

DOS and DON'TS
on Use of RCA-5820-A

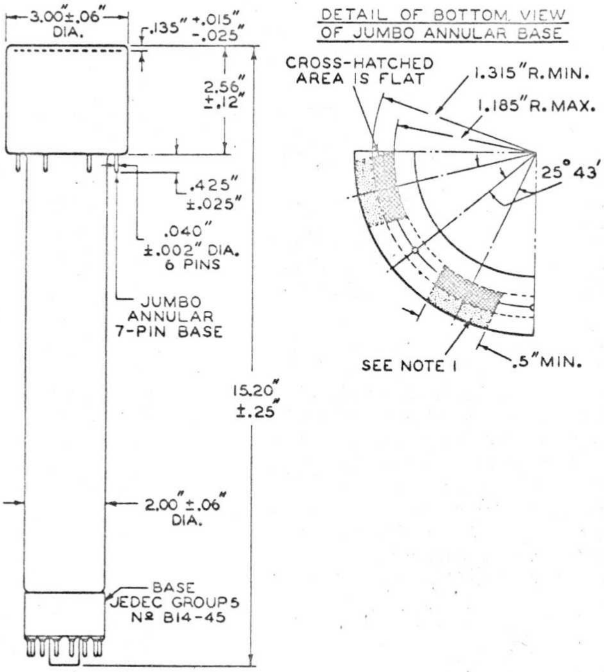
Here are the "dos"—

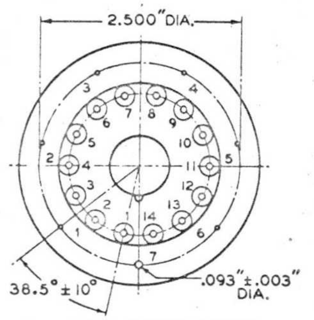
1. Allow the 5820-A to warm up prior to operation.
2. Hold temperature of the 5820-A within operating range.
3. Make sure alignment coil is properly adjusted.
4. Adjust beam-focus control for best usable resolution.
5. Condition spare 5820-A's by operating several hours once each month.
6. Determine proper operating point with target voltage adjusted to exactly 2 volts above target cutoff.
7. Keep beam current as low as possible for best picture quality and to prevent excessive noise.
8. Cap lens during standby operation.

Here are the "don'ts"—

1. Don't force the 5820-A into its shoulder socket.
2. Don't operate the 5820-A without scanning.
3. Don't underscan target.
4. Don't operate a 5820-A having an ion spot.
5. Don't focus the 5820-A on a stationary bright scene.
6. Don't turn off beam while voltages are applied to photocathode, grid-No.6, target, dynodes, and anode during warmup or standby operation.

DIMENSIONAL OUTLINE





ENLARGED BOTTOM VIEW

NOTE 1: DOTTED AREA IS FLAT OR EXTENDS TOWARD DIHEPTAL-BASE END OF TUBE BY 0.060" MAX.

ANNULAR BASE GAUGE

ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK CYLINDER WILL FIT FLAT-PLATE GAUGE WITH:

a. SIX HOLES HAVING DIAMETER OF 0.065" ± 0.001" AND ONE HOLE HAVING DIAMETER OF 0.150" ± 0.001". ALL HOLES HAVE DEPTH OF 0.265" ± 0.001". THE SIX 0.065" HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047". ALL HOLES ARE SPACED AT ANGLES OF 51°26' ± 5' ON CIRCLE DIAMETER OF 2.500" ± 0.001".

b. SEVEN STOPS HAVING HEIGHT OF 0.187" ± 0.001", CENTERED BETWEEN PIN HOLES, TO BEAR AGAINST FLAT AREAS OF BASE.

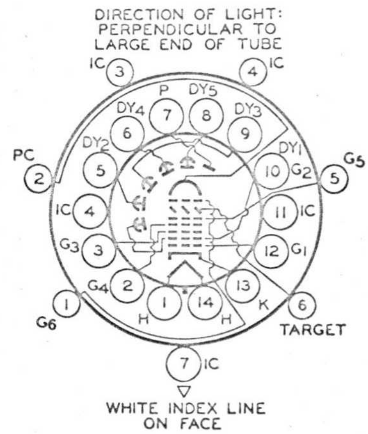
c. RIM EXTENDING OUT A MINIMUM OF 0.125" FROM 2.812" DIAMETER AND HAVING HEIGHT OF 0.126" ± 0.001".

d. NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200" ± 0.001".

92CM-8293R3

BASING DIAGRAM

Bottom View



SMALL-SHELL DIHEPTAL 14-PIN BASE

PIN 1: HEATER
PIN 2: GRID No.4
PIN 3: GRID No.3
PIN 4: INTERNAL CONNECTION—DO NOT USE
PIN 5: DYNODE No.2
PIN 6: DYNODE No.4
PIN 7: ANODE
PIN 8: DYNODE No.5
PIN 9: DYNODE No.3
PIN 10: DYNODE No.1, GRID No.2
PIN 11: INTERNAL CONNECTION—DO NOT USE
PIN 12: GRID No.1
PIN 13: CATHODE
PIN 14: HEATER

KEYED JUMBO ANNULAR 7-PIN BASE

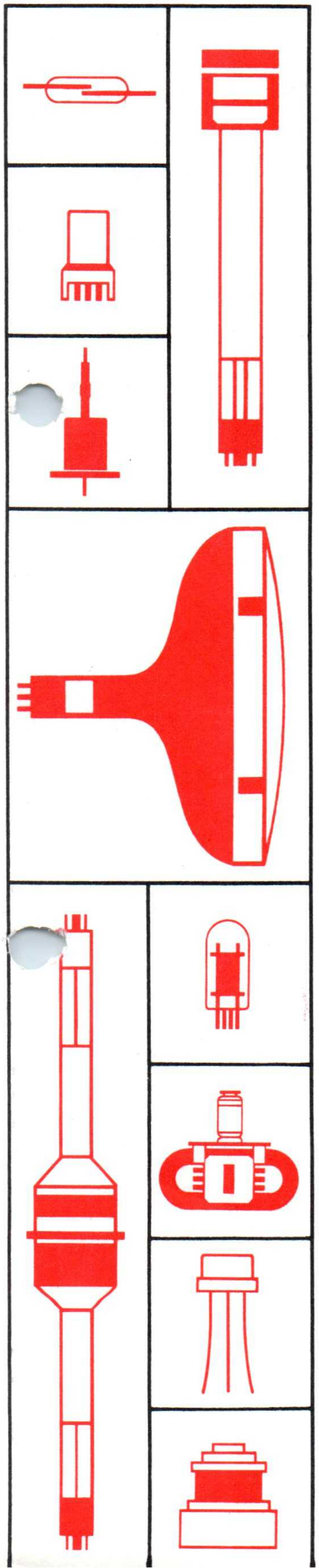
PIN 1: GRID No.6
PIN 2: PHOTOCATHODE
PIN 3: INTERNAL CONNECTION—DO NOT USE
PIN 4: INTERNAL CONNECTION—DO NOT USE
PIN 5: GRID No.5
PIN 6: TARGET
PIN 7: INTERNAL CONNECTION—DO NOT USE

NEW PRODUCT ANNOUNCEMENT

RADIO CORPORATION OF AMERICA

INTERNATIONAL DIVISION / HARRISON, N. J.

LICENSEE SERVICE



RCA-6159B
NEW BEAM POWER TUBE

FULL POWER OUTPUT FROM "IDLING" TO "FULL THROTTLE" is now achieved to bring new reliability to airborne communications. The 6159B operates with 26.5 volts on the heater and handles voltage fluctuations over the range of 21 to 31 volts. In addition, it displays features similar to the recently announced RCA-6146B/8298A and RCA-6883B/8032A/8552.

FEATURES:

- Higher Ratings for Plate-dissipation, Plate-current, and Temperature than Its Prototype
- Controlled for Power Output at Reduced Heater Voltage
- Controlled to Minimize "burnout" during Periods of Momentary Heater Overvoltage
- RCA "dark heater" for More Efficient Heat Transfer to the Cathode

ADVANTAGES:

- Higher Power Output is Possible in New or Modified Equipment Designs

85 Watts CW Output (ICAS) at 60 Mc	**50 Watts CW Output (ICAS) at 175 Mc**

- Life Expectancy is Increased when Replacing 6159 or 6159A without Modifications in Existing Designs

Detailed technical Information is given in the attached bulletin.

April 8, 1964

RCA-6159B

BEAM POWER TUBE

Controlled Zero-Bias Plate Current	85 Watts CW Output (ICAS) at 60 Mc	3-13/16" Max. Length
Controlled Power Output at Reduced Heater Voltage	50 Watts CW Output (ICAS) at 175 Mc	1-21/32" Max. Diameter
	RCA "Dark Heater" with	Octal 8-Pin Base
	21- to 31-volt Range	Small, Sturdy Structure

RCA-6159B is a small, sturdy, beam power tube having high efficiency and high power sensitivity for use in aircraft, mobile and stationary equipment. It is rated as an af power amplifier and modulator, a linear rf power amplifier, and a Class C rf power amplifier and oscillator.

The 6159B features a heater designed to operate over a voltage range of 24 to 29 volts and which will take excursions from 21 to 31 volts in battery operation. The heater design insures dependable performance in mobile equipment under operating conditions during battery charging and discharging. See *Special Performance Data* on page 4 for information covering heater overvoltage and undervoltage operation.

Controlled zero-bias plate current is offered in the 6159B to insure more dependable performance as a Class AB_1 linear rf amplifier for single-sideband suppressed-carrier service. See *Test No.3* of *Characteristics Range Values.*

Also featured in the design of the 6159B is the new RCA "Dark Heater", which functions efficiently at operating temperatures 350° K below those of the heaters in conventional tube types. The dark surface of the new heater radiates heat more efficiently and improves the transfer of heat to the cathode so that optimum cathode temperature may be attained with the heater operating at approximately 1350° K.

The low operating temperature of the "Dark Heater" results in (1) lower internal stresses in the heater wire and smaller thermal change during heater warmup, (2) cooler operation of the heater which minimizes changes in heater shape and reduces the possibility of heater damage and heater shorts, (3) extremely stable heater current characteristics throughout life, and (4) significant reduction in effects of ac heater leakage.

Small in size for its power-output capability, the 6159B has a rugged button-stem construction with short internal leads, a T12 bulb, triple base-pin connections for grid No.3 and cathode (both joined to internal shield inside the tube) to permit effective rf grounding, and an octal base with short metal sleeve having its own base-pin terminal. The sleeve shields the input to the tube and isolates it from the output circuit so completely that no other external shielding is required. Separation of input and output circuits is accomplished by bringing the plate lead out of the bulb to a cap opposite the base.

The 6159B is unilaterally interchangeable with the 6159 and 6159A.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:

Voltage (AC or DC)	26.5	volts
Current at 26.5 volts	0.3	amp
Minimum heating time	60	sec

See Special Performance Data on page 4 for heater operation in stationary equipment and in mobile equipment.

Transconductance, for plate volts = 200, grid-No.2 volts = 200, and plate ma. = 100	7000	μmhos
Mu-Factor, Grid No.2 to Grid No.1 for plate volts = 200, grid-No.2 volts = 200, and plate ma. = 100	4.5	
Direct Interelectrode Capacitances (Approx.):[a]		
Grid No.1 to plate	0.24 max.	pf
Grid No.1 to cathode & grid No.3 & internal shield, base sleeve, grid No.2, and heater	13	pf
Plate to cathode & grid No.3 & internal shield, base sleeve, grid No.2, and heater	8.5	pf

Mechanical:

Operating Position	Any
Maximum Overall Length	3-13/16"
Seated Length	3-1/8" ± 1/8"
Maximum Diameter	1-21/32"
Bulb	T12
Cap	Small (JEDEC No.C1-1)
Base	Small-Wafer Octal 8-Pin with Sleeve (JEDEC Group 1, No.B8-150), or Small-Wafer Octal 8-Pin with External Barriers and Sleeve (JEDEC Group 1, No.B8-159)
Bulb Temperature (At hottest point)	260 max. °C
Weight (Approx.)	2.3 oz

AF POWER AMPLIFIER & MODULATOR — Class AB_1

Maximum Ratings, *Absolute-Maximum-Values:*

	CCS	*ICAS*	
DC Plate Voltage	600 max.	750 max.	volts
DC Grid-No.2 Voltage	250 max.	250 max.	volts
Max.-Signal DC Plate Current[b]	175 max.	220 max.	ma
Max.-Signal Plate Input[b]	90 max.	120 max.	watts

	CCS	ICAS	
Max.-Signal Grid-No.2 Input[b]	3 max.	3 max.	watts
Plate Dissipation[b]	27 max.	35 max.	watts
Peak Heater-Cathode Voltage:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts

Typical Operation:

Values are for 2 tubes

DC Plate Voltage	600	750	volts
DC Grid-No.2 Voltage[c]	200	200	volts
DC Grid-No.1 Voltage:			
With fixed-bias source	-47	-48	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage[d]	94	96	volts
Zero-Signal DC Plate Current	48	50	ma
Max.-Signal DC Plate Current	250	250	ma
Max.-Signal DC Grid-No.2 Current	14.8	12.6	ma
Effective Load Resistance (Plate to plate)	5600	7200	ohms
Max.-Signal Driving Power (Approx.)	0	0	watts
Max.-Signal Power Output (Approx.)	96	124	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance under Any Condition:[e]

With fixed bias	0.1 max.	megohm
With cathode bias	Not recommended	

AF POWER AMPLIFIER & MODULATOR – Class AB_2

Maximum Ratings, *Absolute-Maximum Values:*

	CCS	ICAS	
DC Plate Voltage	600 max.	750 max.	volts
DC Grid-No.2 Voltage	250 max.	250 max.	volts
Max.-Signal DC Plate Current[b]	175 max.	220 max.	ma
Max.-Signal Plate Input[b]	90 max.	120 max.	watts
Max.-Signal Grid-No.2 Input[b]	3 max.	3 max.	watts
Plate Dissipation[b]	27 max.	35 max.	watts
Peak Heater-Cathode Voltage:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts

Typical CCS Operation:

Values are for 2 tubes

DC Plate Voltage	500	600	volts
DC Grid-No.2 Voltage[c]	200	200	volts
DC Grid-No.1 Voltage:			
From a fixed-bias source	-46	-48	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	108	106	volts
Zero-Signal DC Plate Current	50	40	ma
Max.-Signal DC Plate Current	308	270	ma
Max.-Signal DC Grid-No.2 Current	26	27	ma
Max.-Signal DC Grid-No.1 Current	2.7	1.3	ma
Effective Load Resistance (Plate to plate)	3620	5200	ohms
Max.-Signal Driving Power (Approx.)[f]	0.2	0.7	watt
Max.-Signal Power Output (Approx.)	100	110	watts

Typical ICAS Operation:

Values are for 2 tubes

DC Plate Voltage	600	750	volts
DC Grid-No.2 Voltage[c]	200	150	volts
DC Grid-No.1 Voltage:			
From fixed-bias source	-47	-39	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	114	110	volts
Zero-Signal DC Plate Current	50	40	ma
Max.-Signal DC Plate Current	328	294	ma
Max.-Signal DC Grid-No.2 Current	26	28	ma
Max.-Signal DC Grid-No.1 Current	3.4	7.6	ma
Effective Load Resistance (Plate to plate)	4160	6050	ohms
Max.-Signal Driving Power (Approx.)[f]	0.2	0.5	watt
Max.-Signal Power Output (Approx.)	130	148	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance:[g]

With fixed bias	30,000 max.	ohms
With cathode bias	Not recommended	

LINEAR RF POWER AMPLIFIER, Class AB_1
Single-Sideband Suppressed-Carrier Service

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2

Maximum CCS Ratings, *Absolute-Maximum Values:*

	CCS	ICAS	
DC Plate Voltage	600 max.	750 max.	volts
DC Grid-No.2 Voltage	250 max.	250 max.	volts
DC Plate Current at Peak of Envelope	175 max.	220 max.	ma
Plate Dissipation	27 max.	35 max.	watts
Grid-No.2 Dissipation	3 max.	3 max.	watts
Peak Heater-Cathode Voltage:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts

Typical Operation with "Two-Tone Modulation":

At 30 Mc

DC Plate Voltage	600	750	volts
DC Grid-No.2 Voltage[h]	200	200	volts
DC Grid-No.1 Voltage[h]	-47	-48	volts
Zero-Signal DC Plate Current	24	25	ma
Effective RF Load Resistance	2800	3600	ohms
DC Plate Current at Peak of Envelope	125	125	ma
Average DC Plate Current	86	86	ma

	CCS	ICAS	
DC Grid-No.2 Current at Peak of Envelope.	7.4	6.3	ma
Average DC Grid-No.2 Current	5.0	3.9	ma
Distortion Products Level:[i]			
Third order	24	26	db
Fifth order	30	31	db
Useful Power Output (Approx.):			
Average	24.5	30.5	watts
Peak envelope . . .	49	61	watts

Maximum Circuit Values:

Grid-No.1 Circuit Resistance under Any Condition:		
With fixed bias	30,000 max.	ohms

PLATE-MODULATED RF POWER AMPLIFIER — Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0; at frequencies up to 60 Mc

Maximum Ratings, *Absolute-Maximum Values:*

	CCS	ICAS	
DC Plate Voltage. . .	480 max.	600 max.	volts
DC Grid-No.2 Voltage.	250 max.	250 max.	volts
DC Grid-No.1 Voltage.	-150 max.	-150 max.	volts
DC Plate Current. . .	145 max.	180 max.	ma
DC Grid-No.1 Current.	3.5 max.	4.0 max.	ma
Plate Input	60 max.	85 max.	watts
Grid-No.2 Input . . .	2 max.	2 max.	watts
Plate Dissipation . .	18 max.	23 max.	watts
Peak Heater-Cathode Voltage:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts

Typical Operation:

	CCS	ICAS	
DC Plate Voltage. . .	475	600	volts
DC Grid-No.2 Voltage[j].	165	175	volts
DC Grid-No.1 Voltage[k].	-86	-92	volts
From a grid resistor of	26,000	27,000	ohms
Peak RF Grid-No.1 Voltage	106	114	volts
DC Plate Current. . .	125	140	ma
DC Grid-No.2 Current.	8.5	9.5	ma
DC Grid-No.1 Current (Approx.)	3.3	3.4	ma
Driving Power (Approx.)	0.4	0.5	watt
Power Output (Approx.)	42	62	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance[n] . . 30,000 max. ohms

RF POWER AMPLIFIER & OSC. — Class C Telegraphy and RF POWER AMPLIFIER — Class C FM Telephony

Maximum Ratings, *Absolute-Maximum Values up to 60 Mc:*

	CCS	ICAS	
DC Plate Voltage. . .	600 max.	750 max.	volts
DC Grid-No.2 Voltage.	250 max.	250 max.	volts
DC Grid-No.1 Voltage.	-150 max.	-150 max.	volts
DC Plate Current. . .	175 max.	220 max.	ma
DC Grid-No.1 Current.	3.5 max.	4.0 max.	ma
Plate Input	90 max.	120 max.	watts
Grid-No.2 Input . . .	3 max.	3 max.	watts
Plate Dissipation . .	27 max.	35 max.	watts
Peak Heater-Cathode Voltage:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts

Typical Operation as Amplifier up to 60 Mc:

	CCS	ICAS	
DC Plate Voltage. . .	600	750	volts
DC Grid-No.2 Voltage[l].	200	200	volts
DC Grid-No.1 Voltage[m].	-70	-77	volts
From a grid-No.1 resistor of	24,000	28,000	ohms
Peak RF Grid-No.1 Voltage	90	95	volts
DC Plate Current. . .	150	160	ma
DC Grid-No.2 Current.	10	10	ma
DC Grid-No.1 Current (Approx.)	2.8	2.7	ma
Driving Power (Approx.)	0.3	0.3	watt
Power Output (Approx.)	63	85	watts

Typical Operation as Amplifier at 175 Mc:

	CCS	ICAS	ICAS	
DC Plate Voltage. . .	320	400	435	volts
DC Grid-No.2 Voltage[l].	210	220	230	volts
DC Grid-No.1 Voltage[m].	-52	-55	-56	volts
From a grid resistor of	26,000	30,000	24,000	ohms
Peak RF Grid-No.1 Voltage	65	67	73	volts
DC Plate Current. . .	170	180	210	ma
DC Grid-No.2 Current.	12	12	11	ma
DC Grid-No.1 Current (Approx.)	2	1.9	2.3	ma
Driving Power (Approx.)	2	2	3	watts
Power Output (Approx.)	29	40	50	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance[n] . . 30,000 max. ohms

CHARACTERISTICS RANGE VALUES

	Note	Min.	Max.	
1. Direct Interelectrode Capacitances:				
Grid No.1 to plate	1	-	0.24	pf
Grid No.1 to cathode & grid No.3 & internal shield, base sleeve, grid No.2, and heater. .	1	12.0	15.0	pf
Plate to cathode & grid No.3 & internal shield, base sleeve, grid No.2, and heater	1	7.3	9.5	pf
2. Plate Current.	2	46	94	ma
3. Zero-Bias Plate Current. . .	3	330	-	ma
4. Grid-No.2 Current.	2	-	5.5	ma

Note 1: With no external shield.

Note 2: With heater voltage of 26.5 volts, dc plate voltage of 400 volts, dc grid-No.2 voltage of 200 volts, and dc grid-No.1 voltage of -34 volts.

Note 3: With heater voltage of 26.5 volts, dc plate voltage of 100 volts, dc grid-No.2 voltage of 200 volts, and dc grid-No.1 voltage of -100 volts. Grid No.1 is square-wave pulsed at 1000 kc to zero volts. Limit value is peak-pulse current.

SPECIAL PERFORMANCE DATA ON HEATER OPERATION

Stationary Equipment Operation:

	Min.	Design Center	Max.	
Heater, for Unipotential Cathode:				
Voltage (AC or DC)[a].	-	26.5	-	volts
Current at 26.5 volts	0.28	-	0.32	amp
Useful Power Output[b] .	59	-	-	watts

[a] It is recommended that the design-center heater voltage be 26.5 volts; the heater power supply should not fluctuate more than 10% to insure long life.

[b] In a single-tube, self-excited oscillator circuit, and with ac heater voltage of 26.5 volts, dc plate voltage of 600 volts, dc grid-No.2 voltage of 200 volts, grid-No.1 resistor of 24,000 ± 10% ohms, dc plate current of 150 max. ma., dc grid-No.1 current of 2.5 to 3 ma., and frequency of 15 Mc.

Mobile Equipment Operation:

	Min.	Design Range	Max.	
Heater, for Unipotential Cathode:				
Voltage (AC or DC)[a].	-	24 to 29	-	volts
Current at 26.5 volts	0.28	-	0.32	amp
Useful Power Output I[b].	59	-	-	watts
Useful Power Output II.		See *Note c*		

Overvoltage Heater Life Tests:

Continuous heater life tests are performed periodically on sample lots of tubes with 31 volts on the heater, all other electrodes "floating". Intermittent heater life tests are performed periodically on sample lots of tubes with 43 volts on the heater, a cycle of 1 minute "ON" and 4 minutes "OFF". After 1000 hours of the continuous heater life test and after 48 hours of the intermittent heater life test, the following tests are performed:

With heater voltage of 26.5 volts and ± 100 dc volts between cathode and heater, the heater-cathode leakage current will not exceed 150 microamperes.

With ac or dc heater voltage of 26.5 volts, grid-No.1 volts = -200 and cathode, grid No.2, and plate grounded, the minimum grid-No.1 leakage resistance will be 10 megohms.

With ac or dc heater voltage of 26.5 volts, plate volts = -200, and cathode, grid No.1, and grid No.2 grounded, the minimum plate leakage resistance will be 10 megohms.

[a] It is recommended that the heater voltage operate within the range of 24 to 29 volts and within excursions from 21 to 31 volts in battery operation. See *Useful Power Output Test II* and *Overvoltage Tests.*

[b] In a single-tube, self-excited oscillator circuit, and with ac heater voltage of 26.5 volts, dc plate voltage of 600 volts, dc grid-No.2 voltage of 200 volts, grid-No.1 resistor of 24,000 ± 10% ohms, dc plate current of 150 max. ma., dc grid-No.1 current of 2.5 to 3 ma., and frequency of 15 Mc.

[c] With conditions in note b above, reduce heater voltage to 21 volts. Useful power output will be at least 90% of the power output at heater voltage of 26.5 volts.

a With no external shield.

b Averaged over any audio-frequency cycle of sine-wave form.

c Obtained preferably from a separate source or from the plate voltage supply with a voltage divider.

d The driver stage should be capable of supplying the No.1 grids of the class AB_1 stage with the specified driving voltage at low distortion.

e The type of input coupling network used should not introduce too much resistance in the grid-No.1 circuit. Transformer or impedance coupling devices are recommended.

f Driver stage should be capable of supplying the specified driving power at low distortion to the No.1 grids of the AB_2 stage.

g To minimize distortion, the effective resistance per grid-No.1 circuit of the AB_2 stage should be held at a low value. For this purpose the use of transformer coupling is recommended. In no case, however, should the total dc grid-No.1-circuit resistance exceed 30,000 ohms when the tube is operated at maximum ratings. For operation at less than maximum ratings, the dc grid-No.1-circuit resistance may be as high as 100,000 ohms.

h Obtained preferably from a separate, well-regulated source.

i Referenced to either of the two tones and without the use of feedback to enhance linearity.

j Obtained preferably from a separate source modulated with the plate supply, or from the modulated plate supply through a series resistor.

k Obtained from grid-No.1 resistor or from a combination of grid-No.1 resistor with either fixed supply or cathode resistor.

l Obtained preferably from separate source, or from the plate-supply voltage with a voltage divider, or through a series resistor. A series grid-No.2 resistor should be used only when the tube is used in a circuit which is not keyed. Grid-No.2 voltage must not exceed 435 volts under key-up conditions.

m Obtained from fixed supply, by grid-No.1 resistor, by cathode resistor, or by combination methods.

n When grid No.1 is driven positive and the tube is operated at maximum ratings, the total dc grid-No.1-circuit resistance should not exceed the specified value of 30,000 ohms. If this value is insufficient to provide adequate bias, the additional required bias must be supplied by a cathode resistor or fixed supply. For operation at less than maximum ratings, the dc grid-No.1-circuit resistance may be as high as 100,000 ohms.

DEFINITIONS

AB_1 - The subscript 1 indicates that grid-No.1 current does not flow during any part of the input cycle.

AB_2 - The subscript 2 indicates that grid-No.1 current flows during some part of the input cycle.

CCS - Continuous Commercial Service.

ICAS - Intermittent Commercial and Amateur Service.

Ratings System - The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variation in device characteristics.

Two-Tone Modulation - Two-Tone Modulation operation refers to that class of amplifier service in which the input consists of two monofrequency rf signals having equal peak amplitude.

MAXIMUM RATINGS vs. OPERATING FREQUENCY
In Class C Telegraphy Service

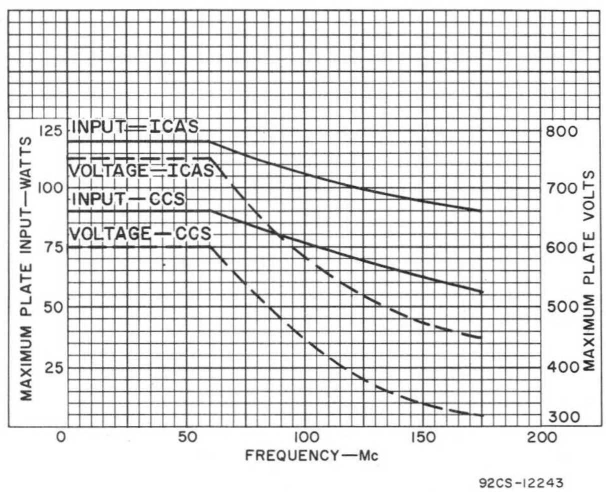


Fig. 1A

MAXIMUM RATINGS vs. OPERATING FREQUENCY
In Class C Telephony Service

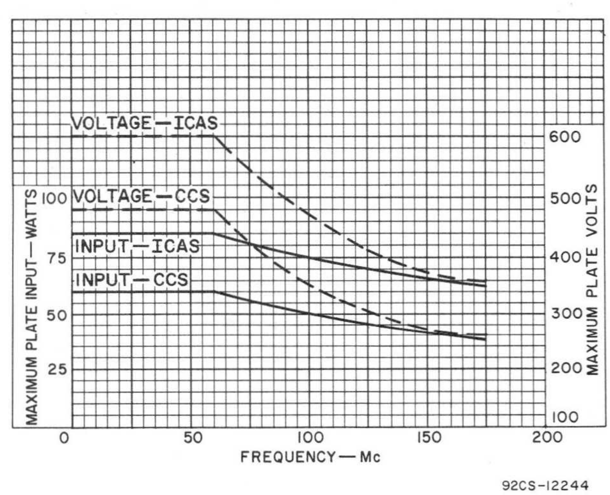


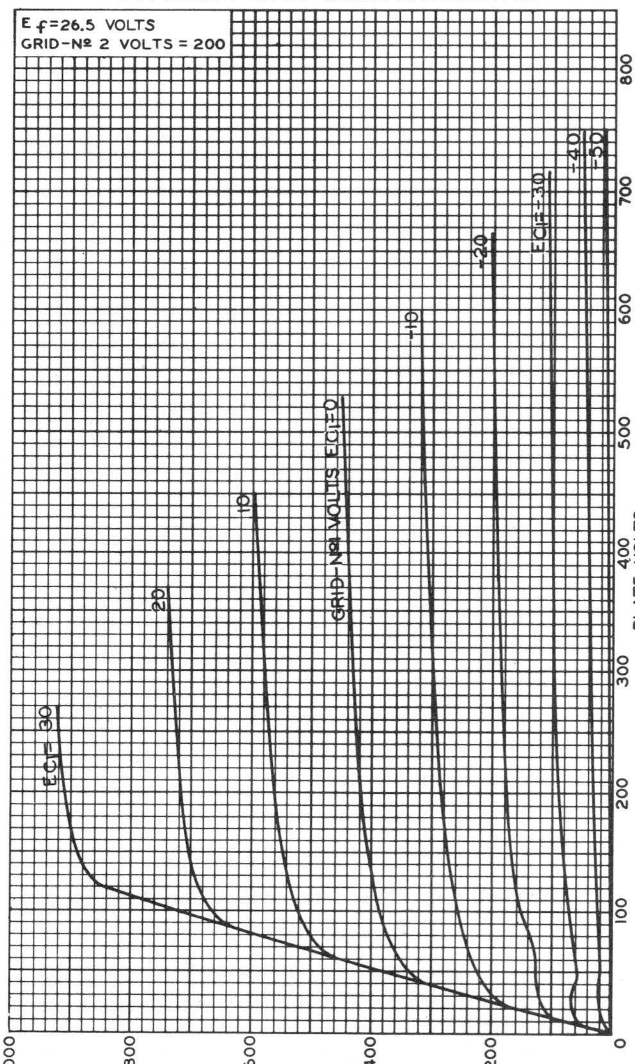
Fig. 1B

GENERAL CONSIDERATIONS

Temperature

The maximum bulb temperature of 260° C is a tube rating and is to be observed in the same manner as other ratings. The temperature may be measured with temperature-sensitive paint, such as Tempilaq. The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, N.Y.

TYPICAL PLATE CHARACTERISTICS



92CM-12516

Fig. 2

To insure adequate cooling it is essential that free circulation of air be provided around the tube. In most cases, no additional air is required.

Plate Color

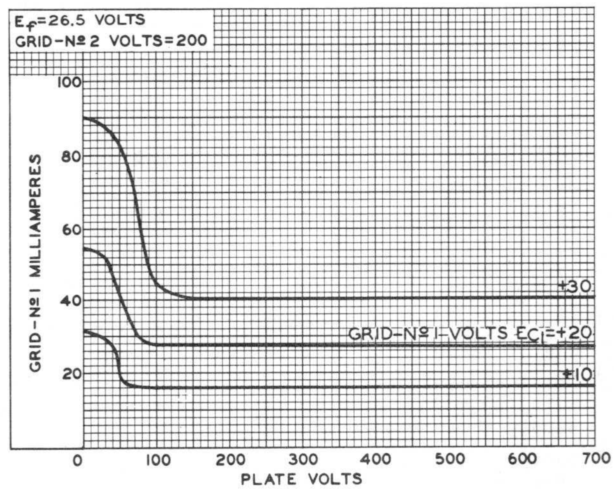
The plate shows no color when the 6159B is operated at full ratings under either CCS or ICAS conditions.

MECHANICAL CONSIDERATIONS

Plate Circuit

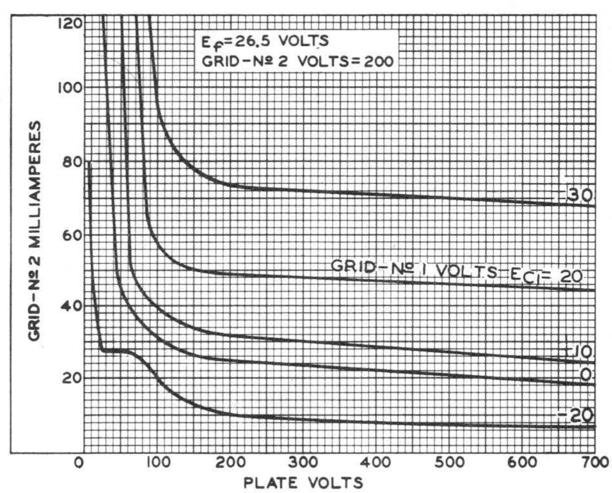
Heavy leads and conductors together with suitable insulation should be used in all parts of the rf plate tank circuit so that losses due to rf voltages and currents may be kept at a minimum. At the higher frequencies, it is essential that short, heavy leads be used for circuit connections in order to minimize lead inductance and losses.

TYPICAL CHARACTERISTICS



92CS-12514

Fig.3



92CS-12515

Fig. 4

Connections to the plate should be made with a flexible lead to prevent any strain on the seal at the cap.

ELECTRICAL CONSIDERATIONS

Plate and Grid No.2

When a new circuit is tried or when adjustments are made, it is advisable to reduce the plate voltage and grid-No.2 voltage. If the 6159B is operated at maximum ratings and grid-No.2 voltage is obtained through a series dropping resistor, the use of a 2500-ohm protective resistor in the high-voltage supply lead is recommended. When a separate grid-No.2 voltage supply is used, a 10,000-ohm protective resistor should be connected in the grid-No.2 supply lead.

The plate voltage should be applied before or simultaneously with the grid-No.2 voltage; otherwise, with voltage on grid No.2 only, its current may be large enough to cause excessive grid-No.2 dissipation. A dc milliammeter should be used in the grid-No.2 circuit so that its current may be measured and the dc power input determined.

The grid-No.2 current is a very sensitive indication of plate-circuit loading and grid-No.2 current rises excessively (often to the point of damaging the tube) when the amplifier is operated without load. Therefore, care should be taken when tuning a 6159B under no-load conditions in order to prevent exceeding the grid-No.2 input rating of the tube.

TYPICAL PLATE CHARACTERISTICS

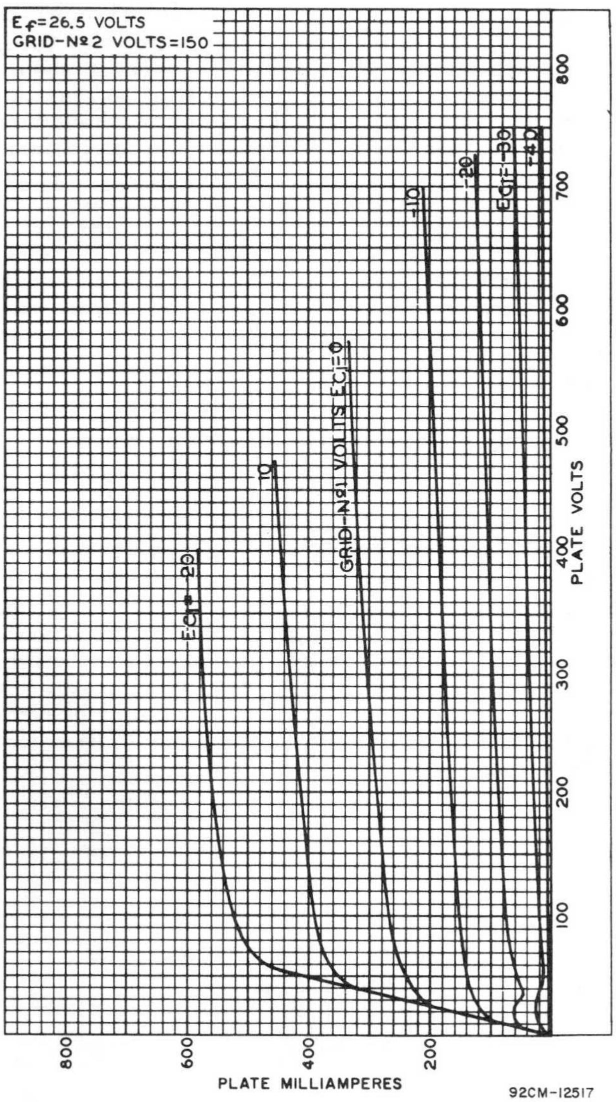


Fig. 5

TYPICAL CHARACTERISTICS

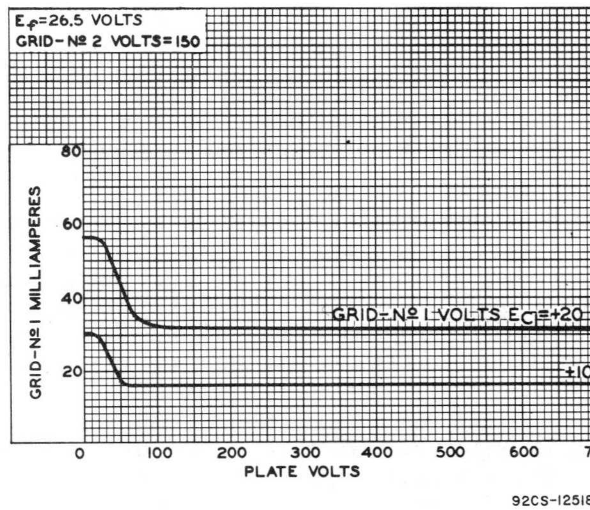


Fig.6

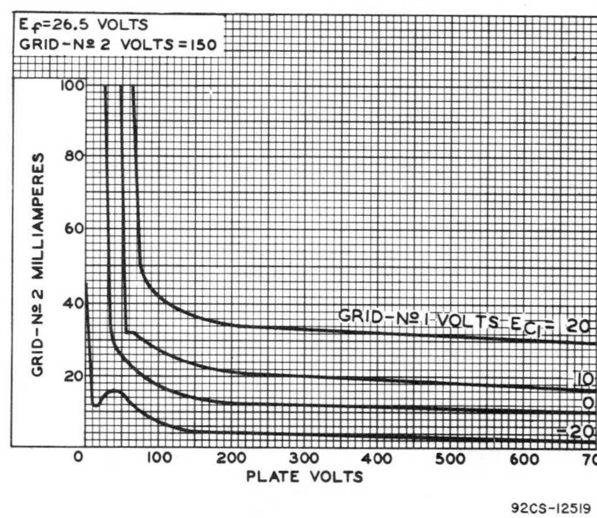


Fig. 7

Driver

The driver stage for the 6159B in either class C telephony or telegraphy service should have considerably more output capability than the typical driving power shown in the tabulated data in order to permit considerable range of adjustment, and also to provide for losses in the grid-No.1 circuit and the coupling circuits. This recommendation is particularly important near the maximum-rated frequency where there are other losses of driving power, such as circuit losses, radiation losses, and transit-time losses.

Efficiency

Highest operating efficiency in high-frequency service, and therefore maximum power output, will be obtained when the 6159B is operated under load conditions such that the maximum rated plate current flows at the plate voltage which will give maximum rated input.

Class C Telephony

In plate-modulated class C amplifier service, the 6159B can be modulated 100 per cent. The grid-No. 2 voltage must be modulated simultaneously with the plate voltage so that the ratio of grid-No. 2 voltage to plate voltage remains constant. Modulation of the grid-No. 2 voltage can be accomplished either by connecting grid No. 2 through a separate winding on the modulation transformer to the fixed grid-No. 2 voltage supply, or by connecting grid No. 2 through an audio-frequency choke of suitable impedance for low audio frequencies to the fixed grid-No. 2 supply voltage. The supply end of the choke should be well bypassed to ground.

Circuit Arrangements

Push-pull or parallel circuit arrangements can be used when more radio-frequency power is required than can be obtained from a single 6159B. Two 6159B's in parallel or push-pull will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage necessary to drive a single tube.

With either connection, the driving power required is approximately twice that for a single tube. The push-pull arrangement has the advantage of simplifying the balancing of high-frequency circuits.

When two or more tubes are used in the circuit, precautions should be taken to insure that each tube draws the same plate current.

Standby Operation

During standby periods in intermittent operation, the heater voltage may be maintained at normal operating value for most applications.

In those applications which require maximum reliability, it is recommended that the heater voltage be maintained at normal operating value when the period is less than 15 minutes; that it be reduced to 80 per cent of normal when the period is between 15 minutes and 2 hours; and that for longer periods, the heater voltage should be turned off.

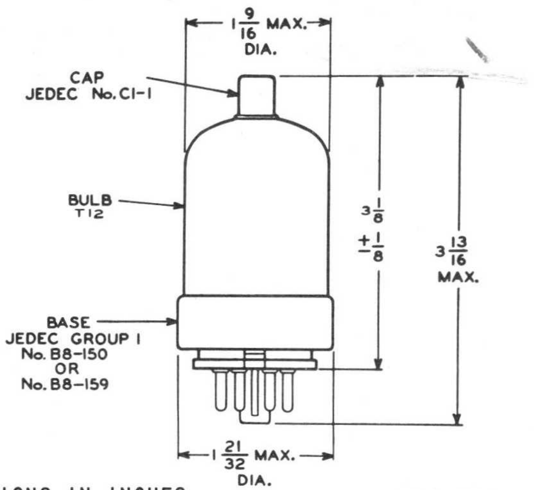
Protective Devices

Protective devices should be used to protect not only the plate but also grid No. 2 against overload. In order to prevent excessive plate current flow and resultant overheating of the tube, the common ground lead of the plate circuit should be connected in series with the coil of an instantaneous overload relay. This relay should be adjusted to remove the dc plate and grid-No. 2 voltage when the average value of plate current reaches a value slightly higher than normal plate current. A protective device in the grid-No. 2 supply should remove the grid-No. 2 voltage when the dc grid-No. 2 current reaches a value slightly higher than normal.

Precautions

The rated plate and grid-No. 2 voltages of this tube are extremely dangerous. Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel can not possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies when any gate or door on the protective housing is opened, and should prevent the closing of the primary circuit until the door is again locked.

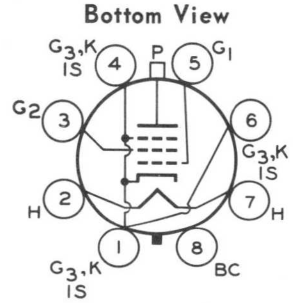
DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES 92CS-12249R1

TERMINAL CONNECTIONS

Bottom View



7CK

PIN 1: CATHODE, GRID No. 3, INTERNAL SHIELD
PIN 2: HEATER
PIN 3: GRID No. 2
PIN 4: SAME AS PIN 1
PIN 5: GRID No. 1
PIN 6: SAME AS PIN 1
PIN 7: HEATER
PIN 8: BASE SLEEVE
CAP: PLATE

RCA electron tube ANNOUNCEMENT

LICENSEE SERVICE

A NEW TUBE..... AN IMPROVED TUBE..... SPECIAL INFORMATION

Tech Pubs

RADIO CORPORATION OF AMERICA
RCA INTERNATIONAL DIVISION
HARRISON, NEW JERSEY

January 21, 1960

RCA-6166-A BEAM POWER TUBE
With Ceramic-Metal Construction

Gentlemen:

We are pleased to announce the new RCA-6166-A -- an air-cooled beam power tube featuring ceramic-metal construction. The 6166-A is intended for service in television and CW applications and is unilaterally interchangeable with the 6166.

Because of its ceramic-metal construction, the 6166-A has somewhat higher maximum plate-voltage ratings than the 6166, and can be operated with full plate voltages and full plate input at frequencies up to 220 Mc.

The coaxial structure of the 6166-A is intended for use with circuits of the coaxial-cylinder type. Its structural design provides low-inductance, large area, rf electrode terminals for insertion into the cylinders. An efficient external radiator provides for plate cooling by means of forced air.

A technical bulletin giving ratings, characteristics, typical operating conditions, dimensions, and operating considerations for the 6166-A is in preparation.

Very truly yours,

R F Simokat

R. F. SIMOKAT
Licensee Service

RFS:vs

6166-A/7007

BEAM POWER TUBE

Ceramic-Metal Seals	For Use with Full Ratings Up to 220 Mc	11.50" Max. Length
Thoriated-Tungsten Filament	Forced-Air Cooled	6.38" Max. Diameter
Coaxial Electrode Structure	12 Kw Plate Dissipation	Integral Radiator

RCA-6166-A/7007 is a forced-air cooled beam power tube designed for vhf service in television and cw applications. It has a maximum plate dissipation of 12 kilowatts in cw and television service, and can be used with full ratings up to 220 megacycles per second.

The 6166-A/7007 features a coaxial-electrode structure, which provides low-inductance, large area, rf electrode terminals. The respective electrode terminals are insulated from each other by low-loss ceramic bushings. This coaxial structure with its ring-type ceramic-metal seals having graduated diameters makes the 6166-A/7007 particularly useful in coaxial-cylinder cavity circuits. An efficient external radiator provides for plate cooling by means of forced air.

The 6166-A/7007 can deliver a synchronizing-level power output of 14 kilowatts in broad-band television service at 216 Mc; a carrier power output of 6 kilowatts in plate-modulated telephony service using conventional grid-drive circuits operating at 60 Mc; and a power output of 12 kilowatts in class C telegraphy service using grid-drive circuits operating at 216 Mc.

GENERAL DATA

Electrical:

Filament, Multistrand Thoriated Tungsten:		
Voltage, (AC or DC)*	5.0 ± 5%	volts
Current at 5 volts	181	amperes
Minimum heating time	15	seconds
Cold resistance	0.0038	ohm
Mu-Factor, Grid No.2 to Grid No.1 for plate volts = 2000, grid-No.2 volts = 1000, and plate amp. = 2	10	
Direct Interelectrode Capacitances:		
Grid No.1 to plate**	0.6 max.	μμf
Grid No.1 to filament	42	μμf
Plate to filament**	0.08 max.	μμf
Grid No.1 to grid No.2	60	μμf
Grid No.2 to plate	24	μμf

Mechanical:

Operating Position	Vertical, filament end up or down
Maximum Overall Length	11.50"
Maximum Diameter	6.38"
Terminal Connections	See *Dimensional Outline*
Radiator	Integral part of tube

Air Flow:

Through Radiator—The specified flow of incoming air at a temperature of 45° C for various plate dissipations, as indicated in the tabulation below, should be delivered by a blower through the radiator before and during the application of any voltages. The air should enter the radiator at its plate-terminal end (see *Dimensional Outline*). Filament power, plate power, grid-No.2 power, and air flow may be removed simultaneously.

Percentage of max. rated plate dissipation for each class of service	100	83	67	50	per cent
Minimum air flow	550	350	230	175	cfm
Static pressure	6.6	3	1.6	1.0	in. of water

To Grid-No.2 Terminal	50 min.	cfm
To Grid-No.1 Terminal and Filament Terminals	50 min.	cfm
Incoming-Air Temperature	50 max.	°C
Radiator Temperature (Measured on the core at end away from incoming air)	180 max.	°C
Terminal Temperature: Filament, grid No.1, grid No.2, and plate	180 max.	°C
Weight (Approx.)	15	pounds

RF POWER AMPLIFIER — Class B Television Service

Synchronizing-level conditions per tube unless otherwise specified
(Voltages are referred to cathode unless otherwise specified)

Maximum CCS● Ratings, *Absolute-Maximum Values:*+

	Up to 220 Mc	
DC PLATE VOLTAGE	7500 max.	volts
DC GRID-NO.2 VOLTAGE	2000 max.	volts
DC PLATE CURRENT	4 max.	amp
PLATE INPUT	24000 max.	watts
GRID-NO.2 INPUT	400 max.	watts
PLATE DISSIPATION	12000 max.	watts
GRID-NO.1 DISSIPATION	300 max.	watts

Typical Operation in Grid-Drive Circuit at 216 Mc:

	Bandwidth▲ of 8.5 Mc	
DC Plate Voltage	5800	volts
DC Grid-No.2 Voltage	1200	volts
DC Grid-No.1 Voltage	−130	volts
Peak RF Grid-No.1 Voltage:		
Synchronizing level	375	volts
Pedestal level	290	volts
DC Plate Current:		
Synchronizing level	3.45	amp
Pedestal level	2.60	amp
DC Grid-No.2 Current (Pedestal Level)	0.207	amp
DC Grid-No.1 Current (Approx.):		
Synchronizing level	0.175	amp
Pedestal level	0.085	amp
Driver Power Output (Approx.):♦		
Synchronizing level	800#	watts
Pedestal level	450	watts
Useful Power Output (Approx.):		
Synchronizing level	12000	watts
Pedestal level	6800	watts

Typical Operation in Cathode-Drive Circuit at 216 Mc:

	Bandwidth▲ of 8.5 Mc	
DC Plate-to-Grid-No.1 Voltage	6400	volts
DC Grid-No.2-to-Grid-No.1 Voltage	800	volts
DC Cathode-to-Grid-No.1 Voltage	90	volts
Peak RF Cathode-to-Grid-No.1 Voltage:		
Synchronizing level	360	volts
Pedestal level	285	volts
DC Plate Current:		
Synchronizing level	3.65	amp
Pedestal level	2.75	amp
DC Grid-No.2 Current (Pedestal Level)	0.175	amp
DC Grid-No.1 Current (Approx.):		
Synchronizing level	0.240	amp
Pedestal level	0.160	amp
Driver Power Output (Approx.):♣		
Synchronizing level	1500##	watts
Pedestal level	850	watts
Useful Power Output (Approx.):		
Synchronizing level	14000	watts
Pedestal level	7900	watts

GRID-MODULATED RF POWER AMPLIFIER — Class C Television Service

Synchronizing-level conditions per tube unless otherwise specified

Maximum CCS● Ratings, *Absolute-Maximum Values:*+

	Up to 220 Mc	
DC PLATE VOLTAGE	7500 max.	volts
DC GRID-NO.2 VOLTAGE	2000 max.	volts
DC GRID-NO.1 VOLTAGE (White level)	−1000 max.	volts
DC PLATE CURRENT	4 max.	amp
PLATE INPUT	24000 max.	watts
GRID-NO.2 INPUT	400 max.	watts
PLATE DISSIPATION	12000 max.	watts
GRID-NO.1 DISSIPATION	300 max.	watts

Typical Operation in Grid-Drive Circuit at 216 Mc:

	Bandwidth▲ of 8.5 Mc	
DC Plate Voltage	5800	volts
DC Grid-No.2 Voltage	1200	volts
DC Grid-No.1 Voltage:		
Synchronizing level	−130	volts
Pedestal level	−195	volts
White level	−350	volts
Peak RF Grid-No.1 Voltage	375	volts
DC Plate Current:		
Synchronizing level	3.45	amp
Pedestal level	2.42	amp
DC Grid-No.2 Current (Pedestal level)	0.148	amp
DC Grid-No.1 Current (Approx.):		
Synchronizing level	0.175	amp
Pedestal level	0.095	amp
Driver Power Output (Approx.):♣		
Synchronizing level	800#	watts
Pedestal level	425	watts
Useful Power Output (Approx.):		
Synchronizing level	12000	watts
Pedestal level	6800	watts

LINEAR RF POWER AMPLIFIER
Single-Sideband Suppressed-Carrier Service

Maximum CCS● Ratings, *Absolute-Maximum Values:*+

	Up to 220 Mc	
DC PLATE VOLTAGE	7500 max.	volts
DC GRID-No.2 VOLTAGE	2000 max.	volts
MAX.-SIGNAL DC PLATE CURRENT	2.8 max.	amp
MAX.-SIGNAL DC GRID-No.1 CURRENT	0.6 max.	amp
MAX.-SIGNAL PLATE INPUT	20000 max.	watts
MAX.-SIGNAL GRID-No.2 INPUT	400 max.	watts
PLATE DISSIPATION	12000 max.	watts

Typical CCS Class AB_2 "Single-Tone" Operation at 60 Mc:⏉

DC Plate Voltage	7000	volts
DC Grid-No.2 Voltage	1200	volts
DC Grid-No.1 Voltage⌀	−125	volts
Zero-Signal DC Plate Current	0.200	amp
Zero-Signal DC Grid-No.2 Current	0	amp
Effective RF Load Resistance	1350	ohms
Max.-Signal DC Plate Current	2.750	amp
Max.-Signal DC Grid-No.2 Current	0.260	amp
Max.-Signal DC Grid-No.1 Current	0.080	amp
Max.-Signal Peak RF Grid-No.1 Voltage	305	volts
Max.-Signal Driving Power (Approx.)	25	watts
Max.-Signal Power Output (Approx.)	12000	watts

PLATE-MODULATED RF POWER AMP. — Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum CCS● Ratings, *Absolute-Maximum Values:*+

	Up to 220 Mc	
DC PLATE VOLTAGE	5500 max.	volts
DC GRID-No.2 VOLTAGE	2000 max.	volts
DC GRID-No.1 VOLTAGE	−1000 max.	volts
DC PLATE CURRENT	2 max.	amp
DC GRID-No.1 CURRENT	0.6 max.	amp
PLATE INPUT	10000 max.	watts
GRID-No.2 INPUT	270 max.	watts
PLATE DISSIPATION	8000 max.	watts

Typical Operation in Grid-Drive Circuit:

	At 60 Mc	
DC Plate Voltage	4800	volts
DC Grid-No.2 Voltage (Modulated 100%)⫯	800	volts
DC Grid-No.1 Voltage★	−300	volts

Peak RF Grid-No.1 Voltage	550	volts
DC Plate Current	1.8	amp
DC Grid-No.2 Current	0.160	amp
DC Grid-No.1 Current (Approx.)	0.180	amp
Driver Power Output (Approx.)♦	125♣♣	watts
Useful Power Output (Approx.)	6000	watts

RF POWER AMPLIFIER & OSC. — Class C Telegraphy□ and RF POWER AMPLIFIER — Class C FM Telephony

Maximum CCS● Ratings, *Absolute-Maximum Values:*+

	Up to 220 Mc	
DC PLATE VOLTAGE	7500 max.	volts
DC GRID-No.2 VOLTAGE	2000 max.	volts
DC GRID-No.1 VOLTAGE	−1000 max.	volts
DC PLATE CURRENT	3.0 max.	amp
DC GRID-No.1 CURRENT	0.6 max.	amp
PLATE INPUT	20000 max.	watts
GRID-No.2 INPUT	400 max.	watts
PLATE DISSIPATION	12000 max.	watts

Typical Operation in Grid-Drive Circuit:

	At 60 Mc	*At 216 Mc*	
DC Plate Voltage	6600	7000	volts
DC Grid-No.2 Voltage●●	1200	1200	volts
DC Grid-No.1 Voltage▲▲	−310	−310	volts
Peak RF Grid-No.1 Voltage	560	560	volts
DC Plate Current	2.75	2.75	amp
DC Grid-No.2 Current	0.300	0.300	amp
DC Grid-No.1 Current (Approx.)	0.140	0.140	amp
Driver Power Output (Approx.)♦	95♦♦	750⊕	watts
Useful Power Output (Approx.)	12000	10000	watts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Filament Current	1	172	190	amp
Direct Interelectrode Capacitances:				
Grid No.1 to plate	2	−	0.60	μμf
Grid No.1 to filament	3	39	47	μμf
Grid No.1 to grid No.2	3	52	64	μμf
Grid No.2 to plate	3	21.2	25.8	μμf
Plate to filament	2	−	0.08	μμf
DC Grid-No.1 Voltage	1,4	−	−225	volts
Peak Grid-No.1 Current	1,5	−	1.5	amp
Peak Grid-No.1 Voltage	1,5	−	315	volts

Note 1: With 5.0 volts ac or dc on filament.

Note 2: With external flat metal shield 12" square having center hole 4-5/16" diameter. Shield is located in plane of the grid-No.2 terminal, perpendicular to the tube axis, and is connected to grid No.2. All other electrodes are grounded.

Note 3: Without shield and all other electrodes grounded.

Note 4: With dc plate voltage of 6000 volts, dc grid-No.2 voltage of 1200 volts, and dc plate current of 20 ma.

Note 5: With dc plate voltage of 1500 volts, dc grid-No.2 voltage of 1200 volts, and instantaneous grid-No.1 voltage adjusted to give peak plate current of 11 amp.

---

* Full rated filament voltage can be applied safely to the cold filament. It is not necessary to provide means for limiting the filament starting current.

** With external flat metal shield 12" square having center hole 4-5/16" diameter. Shield is located in plane of the grid-No.2 terminal, perpendicular to the tube axis, and is connected to grid No.2.

● Continuous Commercial Service.

\+ The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

▲ Computed between half-power points and based on tube output capacitance only.

♦ The driver stage is required to supply tube losses and rf circuit losses. The driver stage should be designed to provide an excess of power above the indicated value to take care of variations in line-voltages, in components, in initial tube characteristics, and in tube characteristics during life.

This value includes 700 watts of rf circuit loss at 216 Mc.

♣ The driver stage is required to supply tube losses, rf circuit losses, and rf power added to plate circuit. The driver stage should be designed as indicated under (♦).

This value includes 470 watts of rf circuit loss at 216 Mc and 1030 watts added to plate circuit.

Ŧ "Single-Tone Modulation" operation refers to that class of amplifier service in which the grid-No.1 input consists of a monofrequency rf signal having constant amplitude. This signal is produced in a single-sideband suppressed-carrier system when a single audio frequency of constant amplitude is applied to the input of the system.

ø Adjusted to give indicated zero-signal plate current.

ǂ Obtained preferably from a separate source.

★ Obtained preferably from a combination of 365-ohm grid-No.1 resistor and −170-volt fixed bias.

♣♣ This value includes 25 watts of rf circuit loss.

□ Key-down conditions per tube without amplitude modulation. Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

●● Obtained preferably from a separate source, or from the plate-supply voltage with a voltage divider, or through a series resistor. A series grid-No.2 resistor should not be used if the 6166-A/7007 or a preceding stage is keyed. In this case, the regulation of the source should be sufficient to prevent the grid-No.2 voltage from rising above 2000 volts under key-up conditions; and additional fixed grid-No.1 bias must be provided to limit the plate current.

▲▲ Obtained from fixed supply, by grid-No.1 resistor, by cathode resistor, or by combination methods.

⊕ This value includes 675 watts of rf circuit loss.

♦♦ This value includes 20 watts of rf circuit loss.

HANDLING and OPERATING CONSIDERATIONS

Avoid bumping this tube. Due to its large mass, bumping this tube will introduce resultant stresses which may cause internal damage.

The 6166-A/7007 should be stored in its shipping container and should be protected from moisture and extreme temperature changes. The preferred storage position of this tube is vertical.

The inner carton in which this tube is packed is not a shock-resisting container. Therefore, it is necessary to handle the tube in its inner carton with the same precautions as for the unpacked tube.

It is recommended that the 6166-A/7007 be tested upon receipt in the equipment in which it is to be used.

Before operating this tube, please refer to the tune-up and operating procedure given in the instruction manual for the equipment in which the tube is to be used. It is recommended procedure to adjust the equipment for operation under heavy plate loading conditions and with only sufficient rf drive to provide the required power output.

Care should be taken to avoid operation of this tube under conditions of insufficient plate loading or excessive rf drive. These operating conditions, especially at the upper end of the VHF range, may produce excessively high seal temperature and resultant damage to this tube.

The *mounting* for the 6166-A/7007 should support the entire weight of the tube by the plate terminal. The mounting should be designed in accordance with the information shown on the Gauge Drawing on page 12. Flexible connectors of the spring-contact type are required for the grid-No.2 terminal and grid-No.1 terminal, and are recommended for the plate terminal. Two connectors are required for the filament terminals. Because of the relatively large high-frequency currents carried by the grid-No.1, grid-No.2, and plate terminals, heavy conductors should be used to make the circuit connections.

Remove the tube from its mounting with a slight rocking, upward action to release the spring-contact fingers. Be sure to lift the tube straight out of its mounting and sufficiently high to prevent bumping the filament terminals against the edge of the mounting.

Cooling of the 6166-A/7007 is accomplished by passing a stream of clean air through the radiator toward the end with the handles and by directing a stream of air onto the filament seals, grid-No.1 terminal, and grid-No.2 terminal.

A suitable air filter is required in the air supply for the radiator. Care should be given to cleaning or replacing the filter at intervals in order that accumulated dirt will not obstruct the required flow of air through the radiator. The required air flow and pressure drop for the radiator for various plate dissipations is shown in Fig.1. In using these curves for determining the cooling requirements of the tube as a plate-modulated rf power amplifier, it should be remembered that 100% sine-wave modulation causes a 50% increase in the plate dissipation above that under carrier conditions. Allowance for pressure drop in air filters, duct work, louvres, etc., should be made in selecting a blower to furnish the required air flow.

The cooling system should be properly installed to insure safe operation of the tube under all conditions and for this reason should be electrically interconnected with the filament and plate power supplies. This arrangement is necessary to make sure that the tube is supplied with air before any voltages are applied. Air-flow interlocks which open the power transformer primaries are desirable for protecting the tube when the air flow is insufficient or ceases.

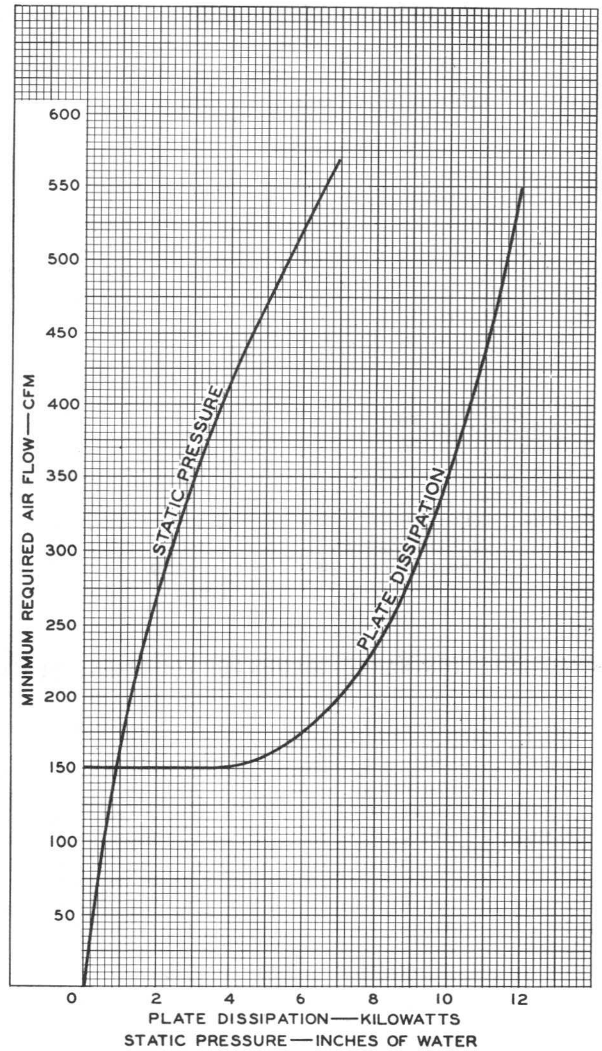


Fig.1 - Cooling Requirements of Type 6166-A/7007.

The *maximum radiator temperature* of 180° C is a tube rating and is to be observed in the same manner as other ratings. The temperature of the radiator should be measured on the core at the end away from the incoming air. The temperature may be measured either with a thermocouple or with temperature-sensitive paint such as Tempilaq. The latter is made by the Tempil Corporation, 132 W. 22nd St., New York 11, N.Y., in the form of liquid and stick.

Similarly, the *maximum terminal temperature* of 180° C is to be observed in the same manner as for other ratings.

The *filament* of the 6166-A/7007 is of the multistrand thoriated-tungsten type. It should be operated at the rated value of 5 volts ± 5%, and must be allowed to reach normal operating temperature before plate and grid-No.2 voltages are applied. The minimum heating time is 15 seconds.

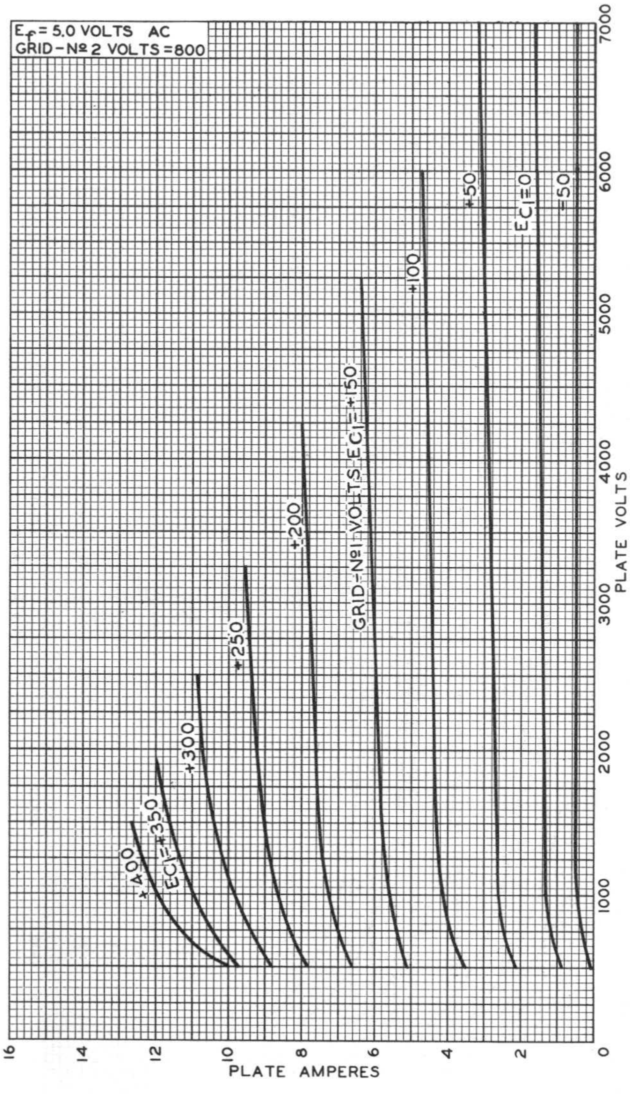


Fig.2 - Average Plate Characteristics of Type 6166-A/7007.

Full rated filament voltage can be applied safely to the cold filament. It is not necessary to provide means for limiting the filament starting current.

During long or frequent standby periods, the 6166-A/7007 may be operated at decreased filament voltage to conserve life. It is recommended that the filament voltage be reduced to 80 per cent of normal during standby periods up to 2 hours; for longer periods, the filament power should be turned off.

Overheating of the 6166-A/7007 by severe overload may decrease the filament emission. The filament activity can sometimes be restored by operating the filament at 5 volts for 10 minutes or more with no voltage on the other electrodes. This process may be accelerated by raising the filament voltage to 6 volts (not higher) for a few minutes.

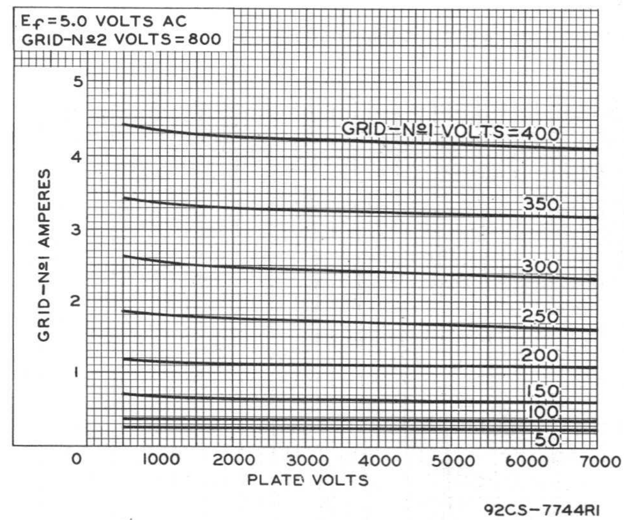


Fig.3 - Average Characteristics of Type 6166-A/7007.

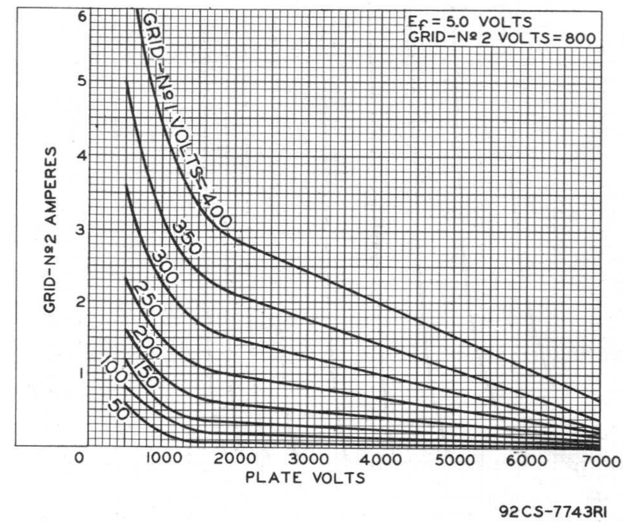


Fig.4 - Average Characteristics of Type 6166-A/7007.

Grid-No.2 voltage should be obtained from a source of good regulation. The plate voltage should be applied before or simultaneously with the grid-No.2 voltage; otherwise, with voltage on grid-No.2 only, its current may be large enough to cause excessive grid-No.2 dissipation. A dc milliammeter should be used in the grid-No.2 circuit so that its current may be measured and the dc power input determined.

The *grid-No.2 current* is a very sensitive indication of plate-circuit loading and rises excessively (often to the point of damaging the tube) when the tube is operated without load. Therefore, care should be taken when tuning the 6166-A/7007 circuit under no-load conditions to prevent exceeding the grid-No.2 input rating of the tube.

The *plate circuit* should be provided with a time-delay relay which will prevent the application of plate voltage before the filament has reached normal operating temperature.

required for operation of the relay and circuit breakers should be about 1/10 second and not more than 1/6 second.

A protective device in the grid-No.2 supply lead should remove the grid-No.2 voltage when the dc grid-No.2 current reaches a value slightly higher than normal.

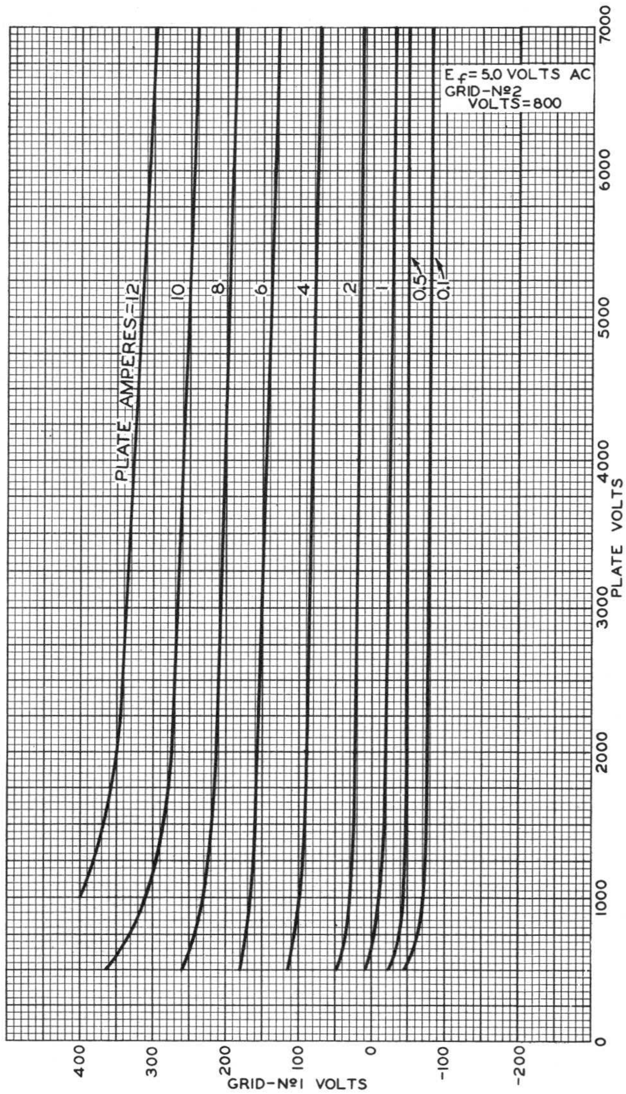


Fig. 5 - Average Constant-Current Characteristics of Type 6166-A/7007.

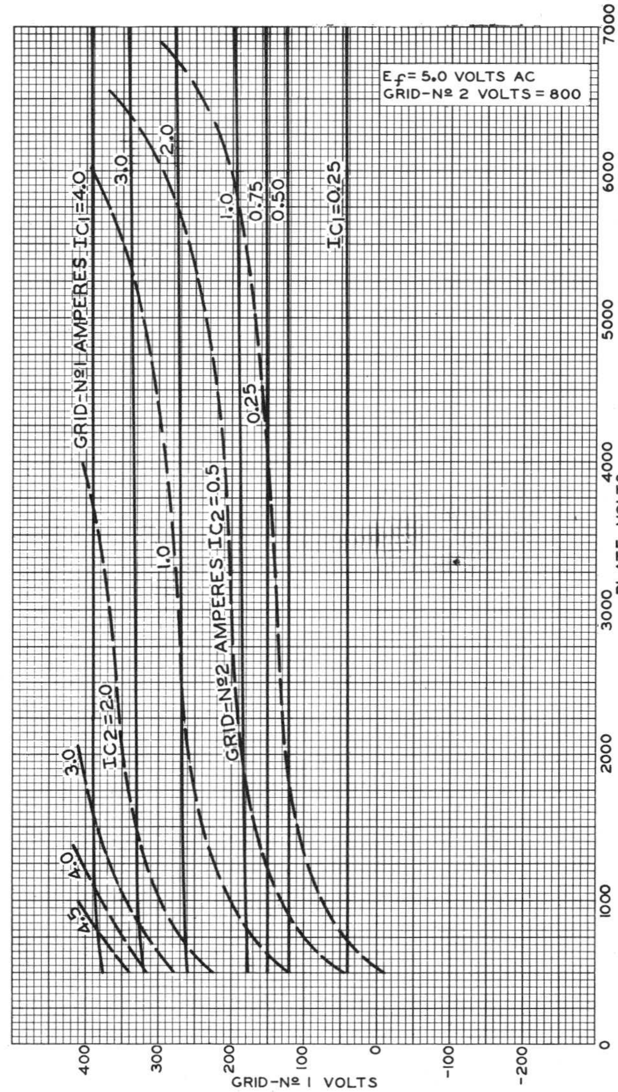


Fig. 6 - Average Constant-Current Characteristics of Type 6166-A/7007.

Protective devices should be used to protect not only the plate but also grid-No.2 against overload. In order to prevent excessive plate-current flow and resultant overheating of the tube, the common ground lead of the plate circuit should be connected in series with the coil of an instantaneous overload relay. This relay should be adjusted to open the circuit breakers in the primary of the rectifier transformer at slightly higher than normal plate current. The time

The *rated plate and grid-No.2 voltages of this tube are extremely dangerous.* Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel cannot possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

In *class B television service*, the 6166-A/7007 should be supplied with grid-No.1 bias in grid-drive circuits, or cathode-to-grid-No.1 bias in cathode-drive circuits, from a source of dc voltage having good regulation. It should not be obtained from a high-resistance source such as a grid resistor. The grid-No.2 voltage should be obtained from a dc source having good regulation.

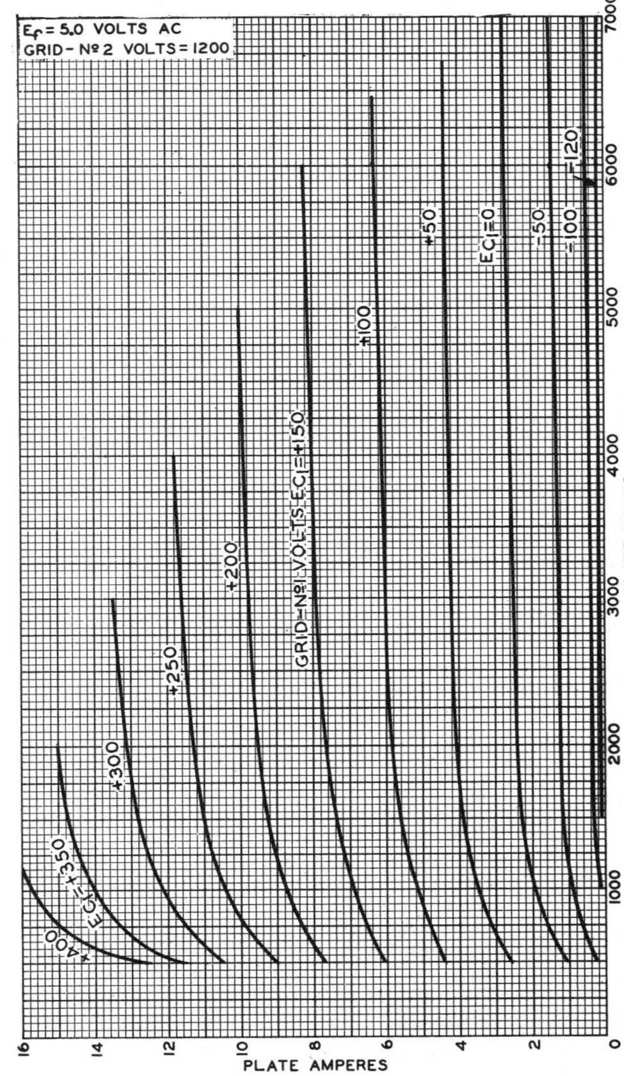
In *class C television service*, the 6166-A/7007 is supplied with unmodulated rf grid-No.1 voltage and with a video-modulated dc grid-No.1 voltage. The grid-No.1 and grid-No.2 voltages should be obtained from well-regulated dc voltage sources.

In *single-sideband suppressed-carrier service*, the grid-No.2 voltage should be obtained from a well-regulated dc voltage source. In AB_2 operation both the grid-No.1 and grid No.2 voltages should be obtained from well-regulated dc voltage sources. Furthermore, in AB_2 operation of the 6166-A/7007, linearity will be assured only by a well-regulated driver. An adequate swamping resistor in the grid-No.1 circuit of the 6166-A/7007 will maintain good driver regulation by offering a load to the driver that is modified only slightly by the additional load of the tube when it is driven into the grid-current region.

In *plate-modulated class C rf power amplifier service*, the 6166-A/7007 should be supplied with bias from a grid-No.1 resistor, or from a suitable combination of grid-No.1 resistor and fixed supply or grid-No.1 resistor and cathode resistor. The cathode resistor should be bypassed for both audio and radio frequencies. The combination method of grid-No.1 resistor and fixed supply has the advantage of not only protecting the tube from damage through loss of excitation but also of minimizing distortion by bias-supply compensation.

Grid-No.2 voltage for the 6166-A/7007 in plate-modulated telephony service should preferably be obtained from a separate source. The grid-No.2 voltage should be modulated simultaneously along with the plate voltage and in such a manner that the ratio of grid-No.2 voltage to plate voltage remains constant. Modulation of the grid-No.2 voltage can be accomplished either by connecting grid No.2 to a separate winding on the modulation transformer or by connecting grid No.2 through a blocking capacitor to a tap on the modulation transformer or choke. With the latter method, an af choke of suitable impedance for low frequencies should be connected in series with the grid-No.2 supply lead.

In *class C rf telegraphy service*, the 6166-A/7007 may be supplied with bias by any convenient method except when the tube is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying. In this case, an amount of fixed bias must be used to limit the plate current and, therefore, the plate dissipation to a safe value. When the 6166-A/7007 is operated at a plate voltage of 5800 volts and grid-No.2 voltage of 1200 volts,



92CM-7735R1

Fig. 7 - Average Plate Characteristics of Type 6166-A/7007.

a fixed bias of -130 volts must be used to limit the plate current to approximately 0.1 ampere.

Grid-No.2 voltage for the 6166-A/7007 in class C telegraphy service should preferably be obtained from a separate source, or from the plate-voltage supply with a voltage divider. It may also be obtained through a series resistor from the plate supply when the 6166-A/7007 or a preceding stage is not keyed. For keyed operation, a fixed source should be used but its regulation need only be sufficient to prevent the grid-No.2 voltage from exceeding 2000 volts under key-up conditions. In this case, additional fixed grid-No.1 bias voltage must be provided to limit the plate current.

In *class C FM telephony service*, the 6166-A/7007 may be supplied with bias by any convenient method. The grid-No.2 voltage should be obtained from a well-regulated dc voltage source. This type of service is similar to conventional class C rf telegraphy service.

In *grid-drive circuits*, the values of driver power output given under *Typical Operation* represent approximately the actual driving power required at the highest frequency specified. At lower frequencies less driving power may be satisfactory because of reduced tube and circuit losses. In all cases, however, the driver stage should be designed to provide an excess of power over that indicated under the typical operating conditions to take care of variations in line voltage, in components, in initial tube characteristics, and in tube characteristics during life.

In *cathode-drive circuits*, there is a further increase in required driving power due to the fact that the grid-No.1 driving voltage and the developed rf plate voltage act in series to supply the load circuit. The increased driving power is not lost because it appears as output from the cathode-drive stage. If the driving voltage and grid-No.1 current are increased, the output will always increase. Such is not the case in a grid-drive circuit where a saturation effect takes place, i.e., above a certain value of driving voltage and current, the output increases very slowly and may even decrease. It is important to recognize this difference and not try to saturate a cathode-drive stage because the maximum grid-No.2 dissipation may easily be exceeded.

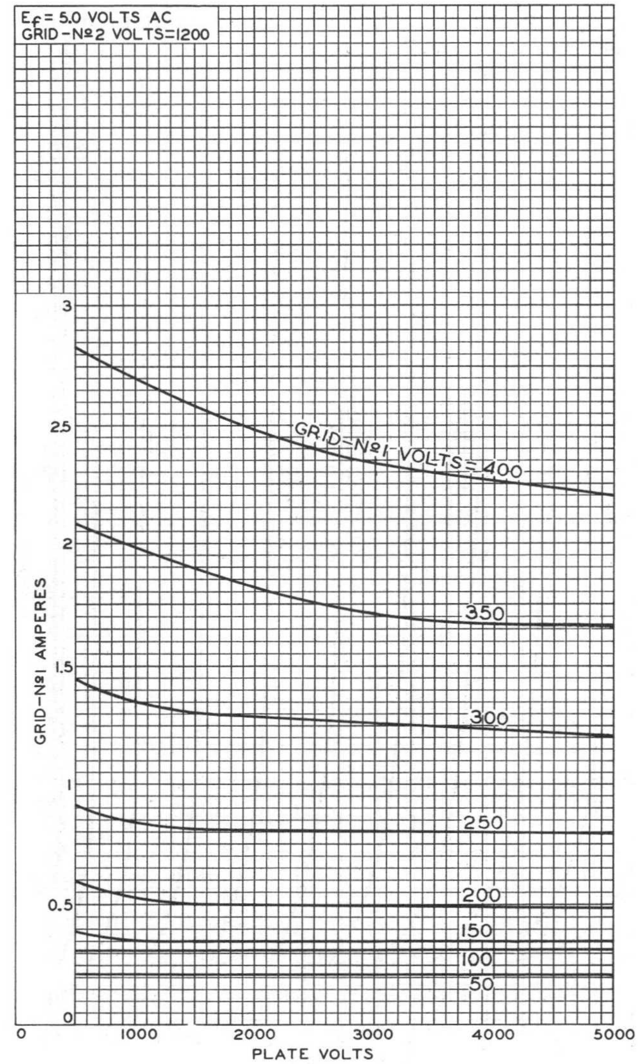


Fig.8-Average Characteristics of Type 6166-A/7007.

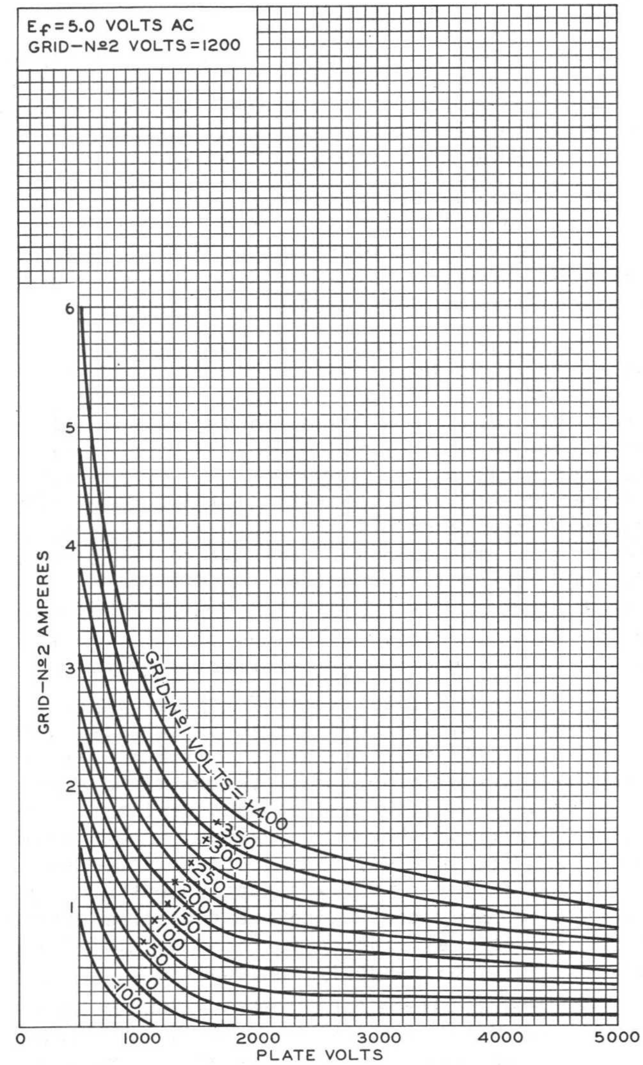
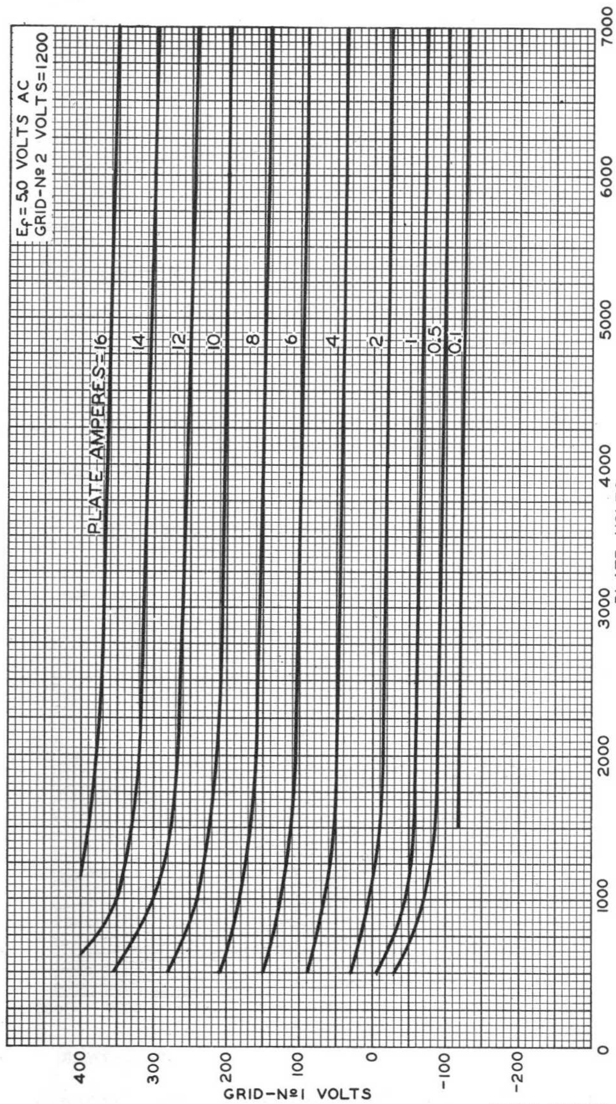


Fig.9-Average Characteristics of Type 6166-A/7007.

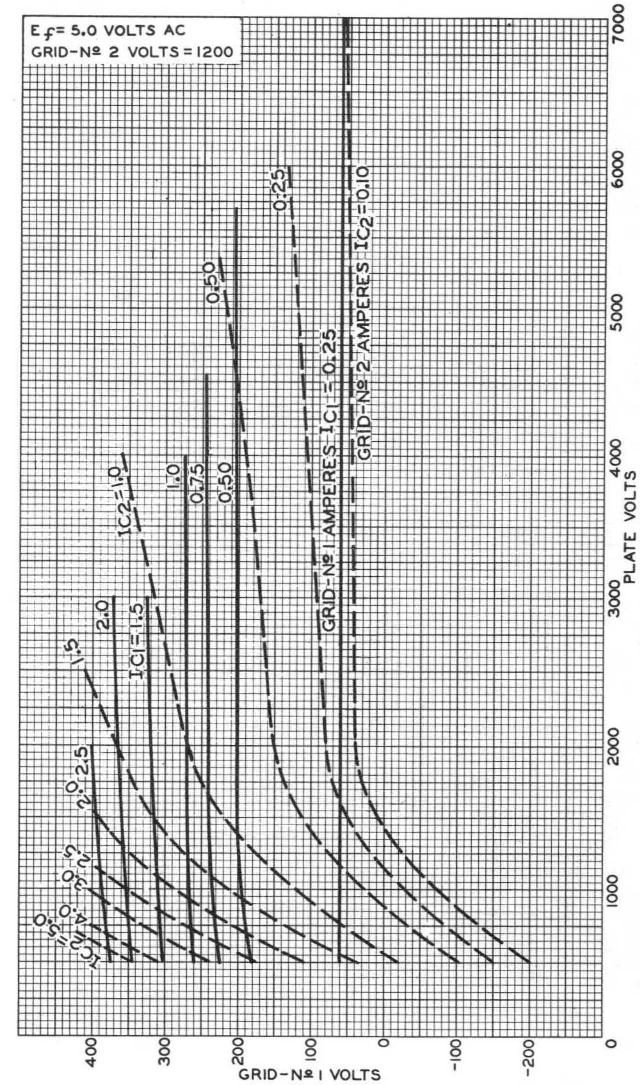
In tuning a cathode-drive rf amplifier, it must be remembered that variations in the load on the output stage will produce corresponding variations in the load on the driving stage. This effect will be noticed by the simultaneous increase in plate currents of both the output and driving stages.



92CM-7733RI

Fig. 10 - Average Constant-Current Characteristics of Type 6166-A/7007.

parallel connection requires no increase in exciting voltage necessary to drive a single tube. With either connection, the driving power required is approximately twice that for a single tube. When two or more tubes are used in the circuit, precautions should be taken to balance the plate currents.



92CM-7730RI

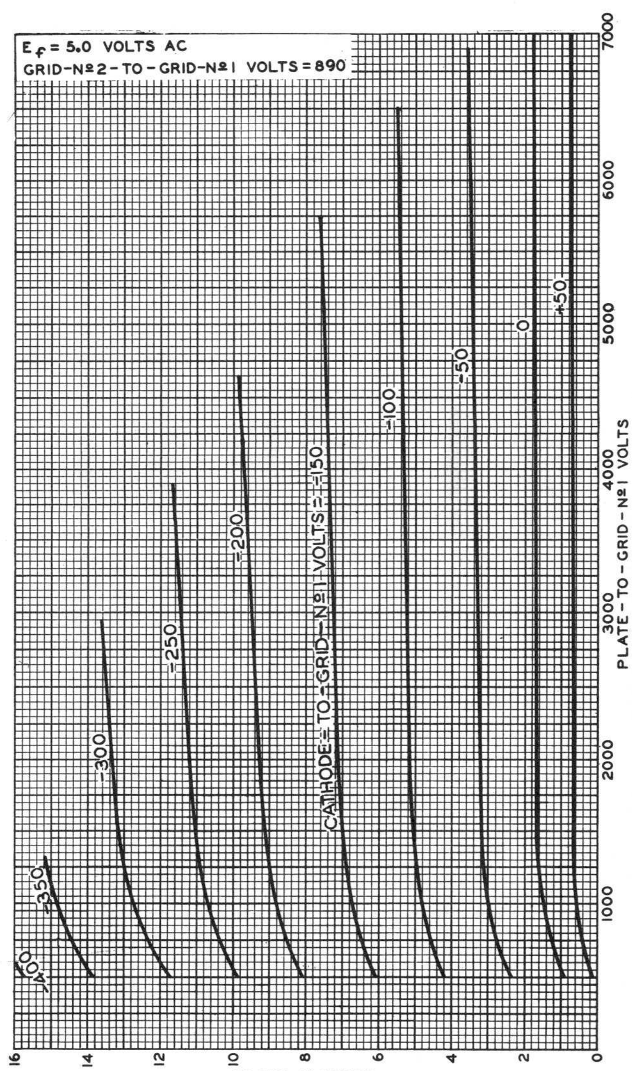
Fig. 11 - Average Constant-Current Characteristics of Type 6166-A/7007.

Push-pull or parallel circuit arrangements may be used when more radio-frequency power is required than can be obtained from a single tube. Two tubes in parallel or push-pull will give approximately twice the power output of one tube. The

REFERENCES

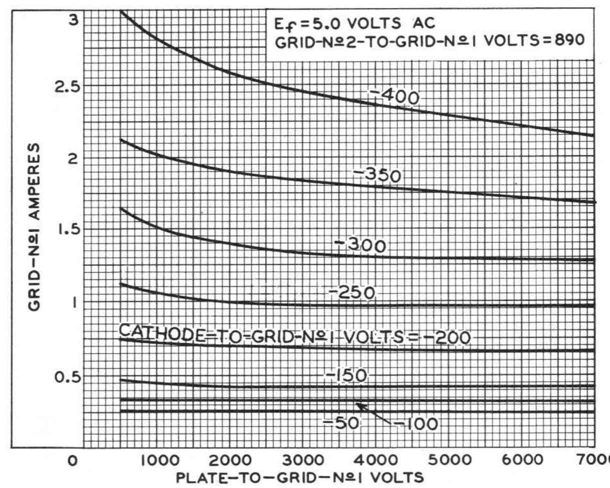
E. E. Spitzer, *"Grounded-Grid Power Amplifiers,"* Electronics, Vol. 19, No.4 pp. 138-141 (April, 1946)

A. G. Nekut, *"Blower Selection for Forced-Air Cooled Tubes,"* Electronics, Vol. 23, No. 8, pp. 88-93 (August, 1950)



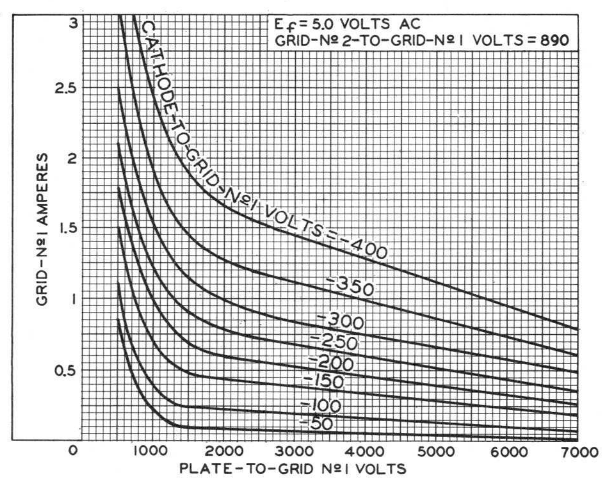
92CM-7750RI

Fig. 12 - Average Plate Characteristics for Cathode-Drive Operation of Type 6166-A/7007.



92CS-7746RI

Fig. 13 - Average Characteristics for Cathode-Drive Operation of Type 6166-A/7007.



92CS-7752RI

Fig. 14 - Average Characteristics for Cathode-Drive Operation of Type 6166-A/7007.

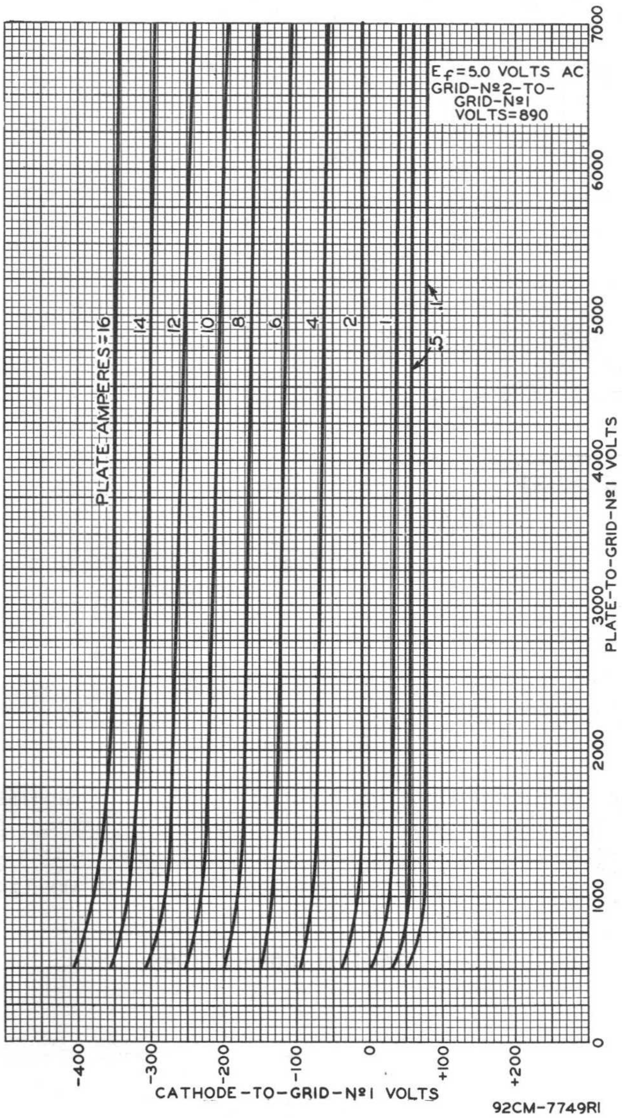


Fig. 15 - Average Constant-Current Characteristics for Cathode-Drive Operation of Type 6166-A/7007.

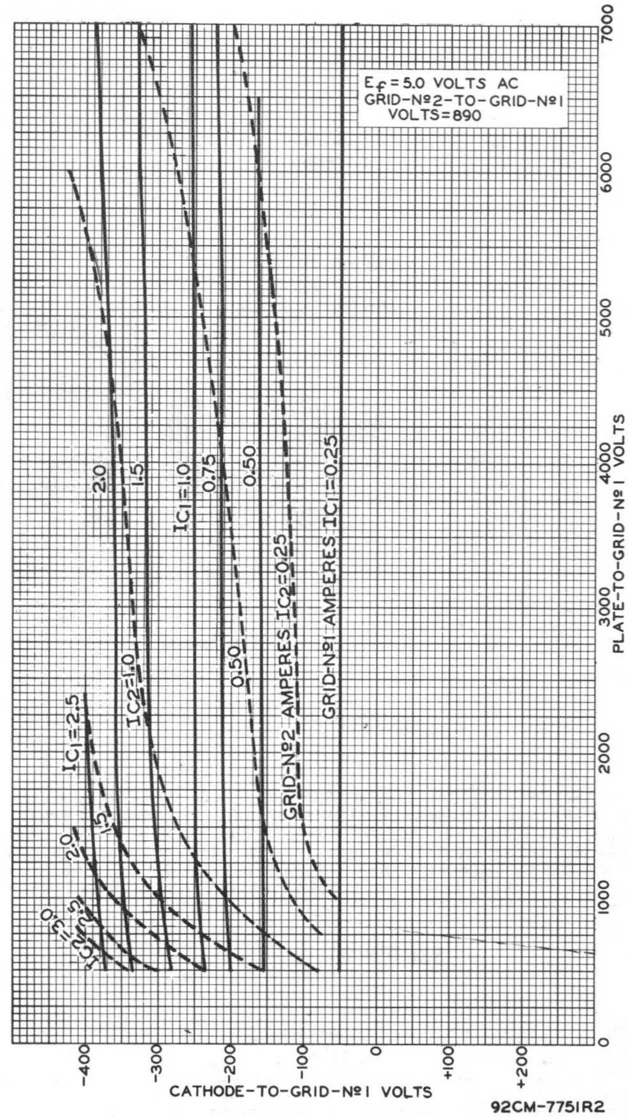
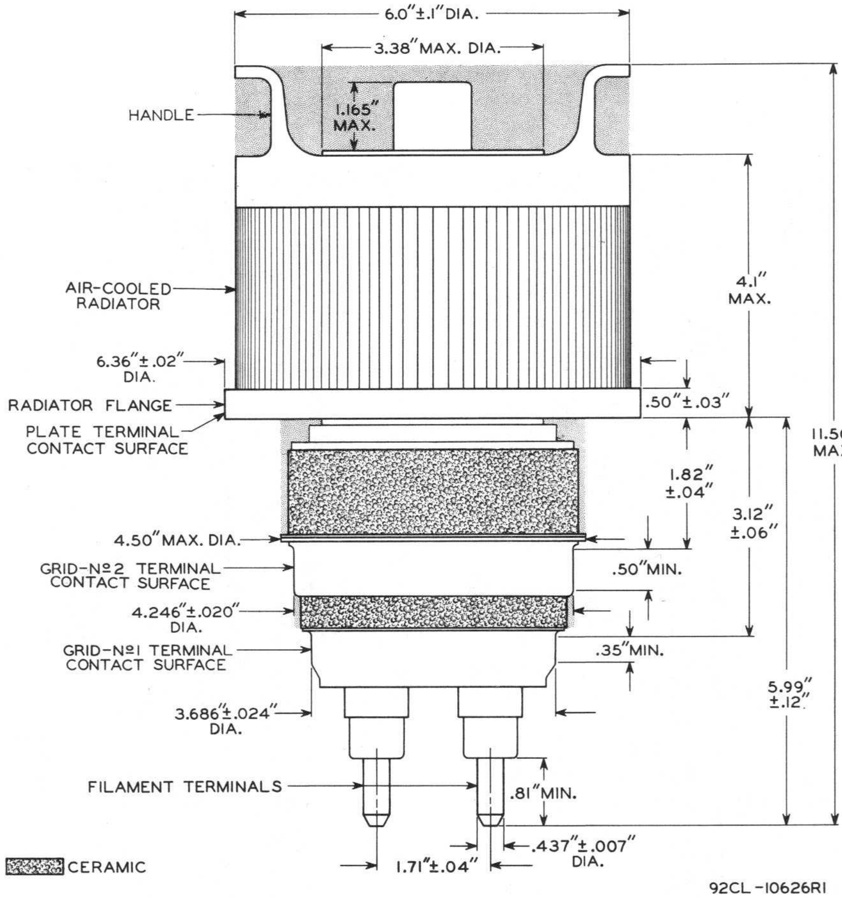


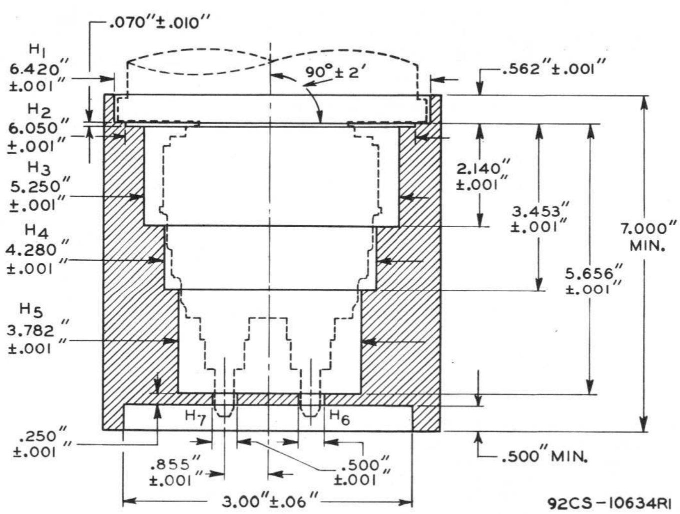
Fig. 16 - Average Constant-Current Characteristics for Cathode-Drive Operation of Type 6166-A/7007.

DIMENSIONAL OUTLINE



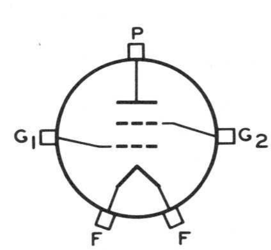
WITH THE CYLINDRICAL SURFACES OF THE PLATE TERMINAL, GRID-No.2 TERMINAL, GRID-No.1 TERMINAL, AND FILAMENT TERMINALS CLEAN, SMOOTH, AND FREE OF BURRS. THE TUBE WILL ENTER A GAUGE AS SHOWN IN SKETCH G_1. PROPER ENTRY OF THE TUBE IN THE GAUGE IS OBTAINED WHEN THE PLATE TERMINAL IS ENTIRELY ENGAGED BY HOLE H_1 AND WILL SEAT ON THE SHOULDER BETWEEN H_1 AND H_2. THE PLANE SURFACE OF THIS SHOULDER IS AT RIGHT ANGLES TO THE AXES OF THE HOLES WITHIN 0° ± 2'. SEATING IS DETERMINED BY FAILURE OF A 0.020" THICKNESS GAUGE TO ENTER MORE THAN 1/16" BETWEEN SHOULDER SURFACE AND PLATE TERMINAL. SLOTS ARE PROVIDED TO PERMIT THIS MEASUREMENT. KEEP ALL STIPPLED REGIONS CLEAR. DO NOT ALLOW CONTACTS OR CIRCUIT COMPONENTS TO PROTRUDE INTO THESE ANNULAR VOLUMES.

SKETCH G_1



THE FIVE CYLINDRICAL HOLES H_1, H_2, H_3, H_4 AND H_5 HAVE AXES COINCIDENT WITHIN 0.001". THE HOLES H_6 AND H_7 HAVE AXES PARALLEL TO THE AXES OF H_1, H_2, H_3, H_4 AND H_5 WITHIN 0° ± 2'.

TERMINAL CONNECTIONS



F: FILAMENT TERMINAL

G_1: GRID-No.1 TERMINAL (Adjacent to Filament Posts)

G_2: GRID-No.2 TERMINAL (Between Grid-No.1 Terminal and Plate Terminal)

P: PLATE TERMINAL (Radiator Flange)

RCA-6199

PHOTOMULTIPLIER TUBE

10-Stage Head-On Type
S-11 Spectral Response

RCA-6199 is a 10-stage, head-on, 1½"-diameter type of photomultiplier tube intended for use in scintillation counters and for the detection and measurement of low-level radiation.

The spectral response of the 6199, at the 10-percent points, covers the approximate range from 3200 angstroms to 6100 angstroms as shown in *Fig.1.* Maximum relative response occurs at about 4400 angstroms, and peak cathode quantum efficiency at about 4200 angstroms.

SPECTRAL RESPONSE CHARACTERISTICS

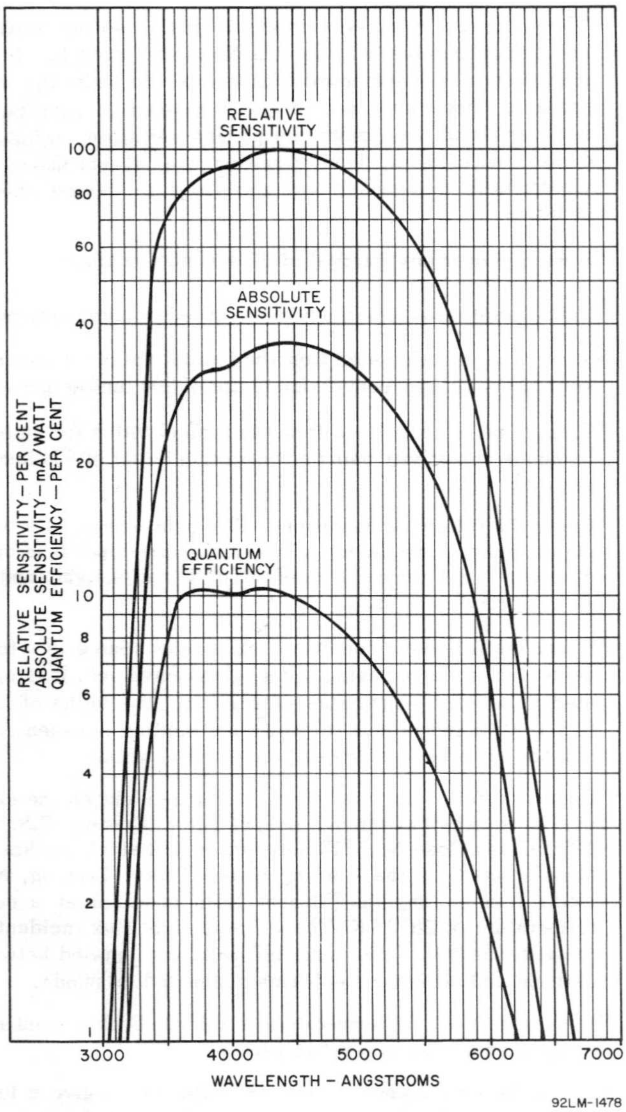


Fig. 1

FEATURES

- **Fast Time Resolution Characteristics –**
  Anode Pulse Rise Time:
  2.5 nanoseconds at 1250 volts
  Electron Transit Time:
  29 nanoseconds at 1250 volts
- **High Current Amplification –**
  1 x 10^6 at 1000 volts
- **Flat Faceplate for Ease in Scintillator Coupling**

DATA

General:

Spectral Response S-11
Wavelength of Maximum
  Response . . . . 4400 ± 500 angstroms
Cathode, Semitransparent . . . . . . Cesium-Antimony
  Shape . . . . Flat-Circular
  Minimum area . . . . 1.2 in^2
  Minimum diameter . . . . 1.24 in
Window . . . Lime Glass, Corning[a] 0080, or equivalent
  Shape . . . . Plano-Plano
  Index of refraction at 5893 angstroms 1.51
Dynodes:
  Substrate . . . . Nickel
  Secondary-Emitting Surface . . . . Cesium-Antimony
  Structure . . . . Circular-Cage
Direct Interelectrode Capacitances (Approx.):
  Anode to dynode No.10 . . . . 4 pF
  Anode to all other electrodes. . . . . 7 pF
Maximum Overall Length . . . . 4.57 in
Seated Length . . . . 3.88 ± 0.19 in
Maximum Diameter . . . . 1.56 in
Bulb. T12
Base . . . . Small-Shell Duodecal 12-Pin, (JEDEC No.B12-43), Non-hygroscopic
Socket . . . . Eby[b] Part No.9058, or equivalent
Magnetic Shield . . . . Millen[c] Part No.80802C, or equivalent
Operating Position . . . . Any
Weight (Approx.). 2.2 oz

Maximum Ratings, *Absolute-Maximum Values:*[d]

DC Supply Voltage:
  Between anode and cathode . . . . 1250 max. volts
  Between anode and dynode
    No.10 . . . . 250 max. volts

Maximum Ratings (Cont'd)

Between consecutive dynodes . . .	200 max.	volts
Between dynode No. 1 and cathode	300 max.	volts
Average Anode Current[e]	0.75 max.	mA
Ambient Temperature[f]	75 max.	°C

Characteristics Range Values for Equipment Design:

Under conditions with supply voltage (E) across voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode.

With E = 1000 volts (Except as noted)

	Min.	Typical	Max.	
Sensitivity:				
Radiant[g] at 4400 angstroms . .	–	3.6×10^{4}	–	A/W
Cathode radiant[h] at 4400 angstroms . .	–	0.036	–	A/W
Luminous[i] .	10	45	300	A/lm
Cathode luminous:				
With tungsten light source[k]	3.0×10^{-5}	4.5×10^{-5}	–	A/lm
With blue light source[m]	2.8×10^{-8}	–	–	A
Cathode quantum efficiency at 4200 angstroms . .	–	10	–	%
Current Amplification . . .	–	1×10^{6}	–	
Equivalent Anode-Dark-Current Input[n]	–	2.3×10^{-10}[p]	2.5×10^{-9}[p]	lm
	–	2.8×10^{-13}[q]	3.1×10^{-12}[q]	W
Anode Dark Current[n,p] . .	–	4.5×10^{-9}	–	A
Dark Current to Any Electrode Except Anode (At 22° C)	–	–	7.5×10^{-7}	A
Equivalent Noise Input[r]	–	4×10^{-12}	1.7×10^{-11}	lm
	–	5×10^{-15}[q]	2.1×10^{-14}[q]	W
Anode-Pulse Rise Time[s] .	–	2.8×10^{-9}	–	sec
Electron Transit Time[t]	–	3.3×10^{-8}	–	sec

[a]Made by Corning Glass Works, Corning, New York.

[b]Made by Hugh H. Eby Company, 4701 Germantown Avenue, Philadelphia 44, Pa.

[c]Made by James Millen Manufacturing Company, 150 Exchange Street, Malden 48, Massachusetts.

[d]The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices. Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[e]Averaged over any interval of 30 seconds maximum.

[f]Tube operation at room temperature or below is recommended.

[g]This value is calculated from the typical value for luminous sensitivity using a conversion factor of 804 lumens per watt.

[h]This value is calculated from the typical value for cathode luminous sensitivity using a conversion factor of 804 lumens per watt.

[i]Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K and a light input of 10 microlumens is used.

[k]Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K. The value of light flux is 0.01 lumen and 167 volts are applied between cathode and all other electrodes connected as anode.

[m]Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning C.S. No. 5-58, Glass Code No.5113 polished to 1/2 stock thickness-Manufactured by the Corning Glass Works, Corning, New York) from a tungsten-filament lamp operated at a color temperature of 2870° K. The value of light flux incident on the filter is 0.01 lumen and 167 volts are applied between cathode and all other electrodes connected as anode.

[n]Measured at a tube temperature of 22° C. Dark current may be reduced by use of a refrigerant.

[p]Measured with supply voltage (E) adjusted to give a luminous sensitivity of 20 amperes per lumen. Dark current is measured with no incident light on tube.

[q]At 4400 angstroms. This value is calculated from the rating in lumen using a conversion factor of 804 lumens per watt.

[r]Under the following conditions: Supply voltage (E) is as shown, 22° C tube temperature, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of 2870° K interrupted at a low audio-frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[s]Measured between 10 per cent and 90 per cent of maximum anode-pulse height. This anode-pulse rise time is primarily a function of transit time variation and is measured under conditions with the incident light fully illuminating the photocathode.

[t]The electron transit time is the time interval between the arrival of a delta function light pulse at the entrance window of the tube and the time at which the output pulse at the anode terminal reaches peak amplitude. The transit time is measured under conditions with the incident light fully illuminating the photocathode.

SCHEMATIC ARRANGEMENT OF STRUCTURE

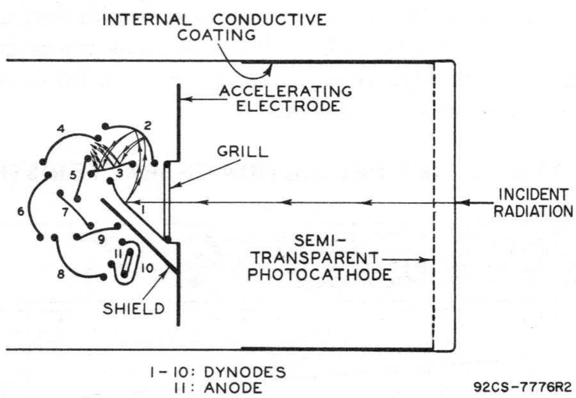


Fig. 2

OPERATING CONSIDERATIONS

Operating Stability:

The *operating stability* of the 6199 is dependent on the magnitude of the anode current. The use of an average anode current well below the maximum rated value of 0.75 milliampere is recommended when stability of operation is important. When maximum stability is required, an average anode current of 10 microamperes should not be exceeded.

Operating Voltages:

In general, the *operating potential between anode and cathode* should not be less than 500 volts.

The *operating voltage between dynode No.10 and anode* should be kept as low as will permit operation over the knee of the anode characteristic curves shown in *Fig.4.* With low operating voltage between dynode No.10 and anode, the ohmic leakage current to the anode is reduced. Operation over the knee occurs in the approximate range of 50 to 100 volts for the light level range shown in *Fig.4.* Under high pulse current conditions, saturation due to space-charge limitations will occur and higher voltage will be required. To obtain the suggested operating voltage between dynode No.10 and anode, it is necessary to increase the supply

TYPICAL SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS

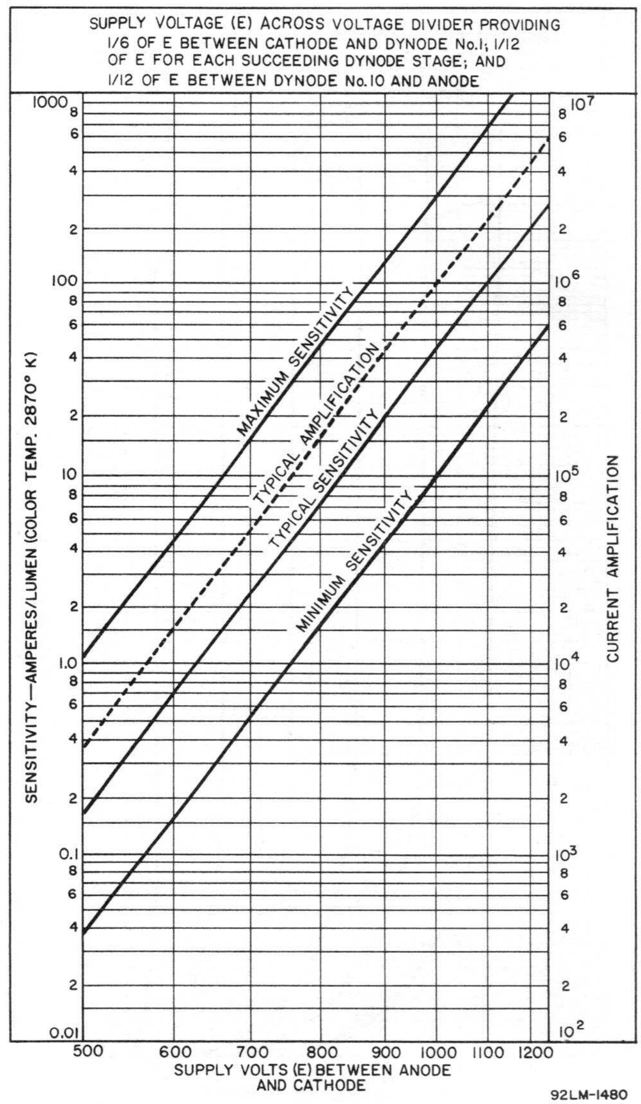


Fig. 3

voltage between these electrodes by an amount equal to the voltage drop across a particular load.

In *applications where minimum electron transit time spread* and more efficient collection of photoelectrons from cathode by dynode No.1 are desired, the potential between cathode and dynode No.1 may be increased to the rated maximum value of 300 volts.

The *operating voltages* for the 6199 can be supplied by spaced taps on a voltage divider across a regulated dc power supply. A typical voltage-divider arrangement for use with the 6199 is shown in *Fig.10.* The choice of resistance values for the voltage-divider string is usually a compromise. If low values of resistance per stage are utilized, the power drawn from the supply and the required wattage rating of the resistors increase. Phototube noise may also increase, due to heating, if the divider network is mounted near the tube. The use of high values of resistance per stage may cause deviation from linearity if the voltage-divider current is not maintained at a value of at least 10 times that of the maximum average anode current and may limit anode current response to pulsed light.

When the ratio of peak anode current to average anode current is high, non-inductive high-quality capacitors should be employed across the latter stages of the tube. The values of these capacitors should be chosen so that sufficient charge is available to prevent a change of more than a few per cent in the interstage voltages throughout the pulse duration.

The *high voltages at which the 6199 is operated* are very dangerous. Care should be taken in the design of apparatus to prevent the operator from coming in contact with these high voltages. Precautions should include the enclosure of high-potential terminals and the use of interlock switches to break the primary circuit of the high-voltage power supply when access to the apparatus is required.

TYPICAL ANODE CHARACTERISTICS

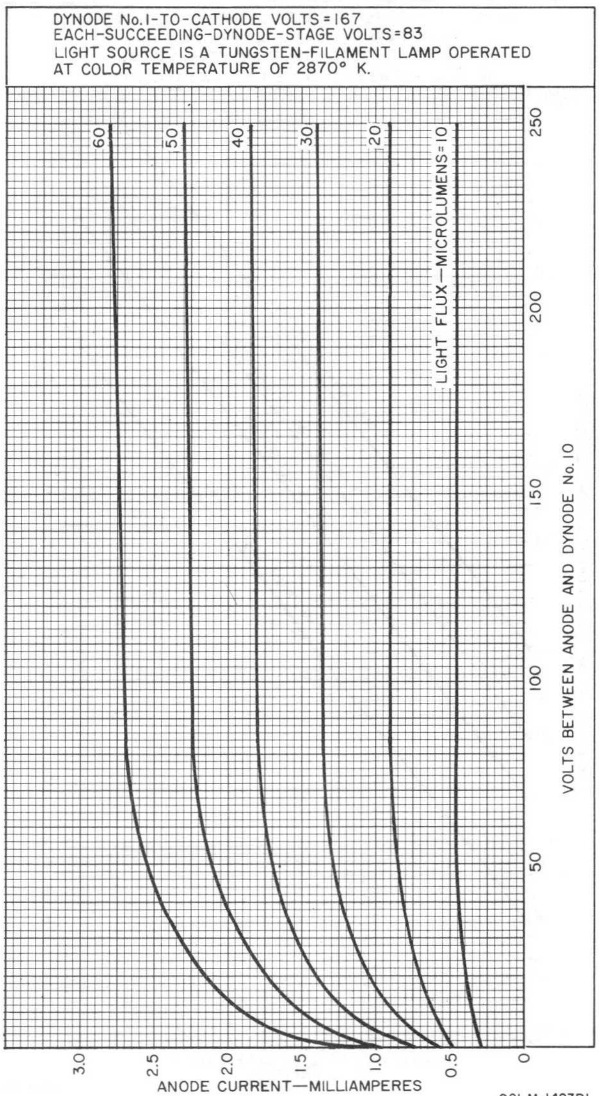


Fig. 4

TYPICAL TIME-RESOLUTION CHARACTERISTICS

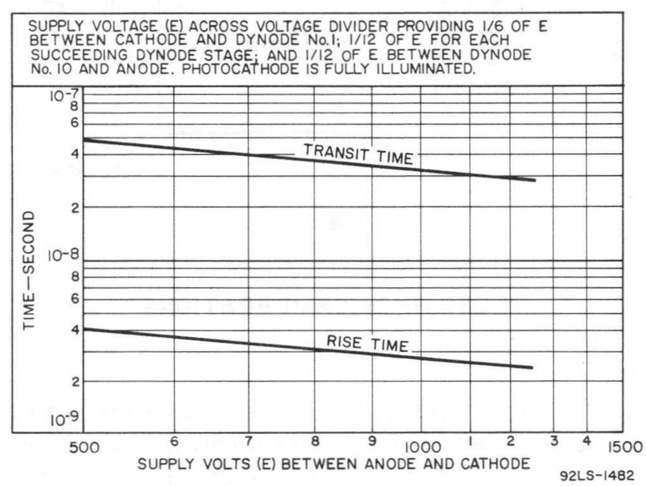


Fig. 5

In the use of the 6199, as with other tubes requiring high voltages, it should always be remembered that these high voltages may appear at points in the circuit which are normally at low potential, because of defective circuit parts or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned off and both terminals of any capacitors grounded.

Dark Current:

A very small *anode dark current* is observed when voltage is applied to the electrodes of the 6199 in complete darkness. Among the components contributing to dark current are ohmic leakage between the anode and adjacent elements and pulses produced by electrons thermionically released from the cathode, secondary electrons released by ionic bombardment of the dynodes, support rods, or cathode, and by cold emission from the electrodes.

TYPICAL DARK CURRENT AND EADCI CHARACTERISTICS

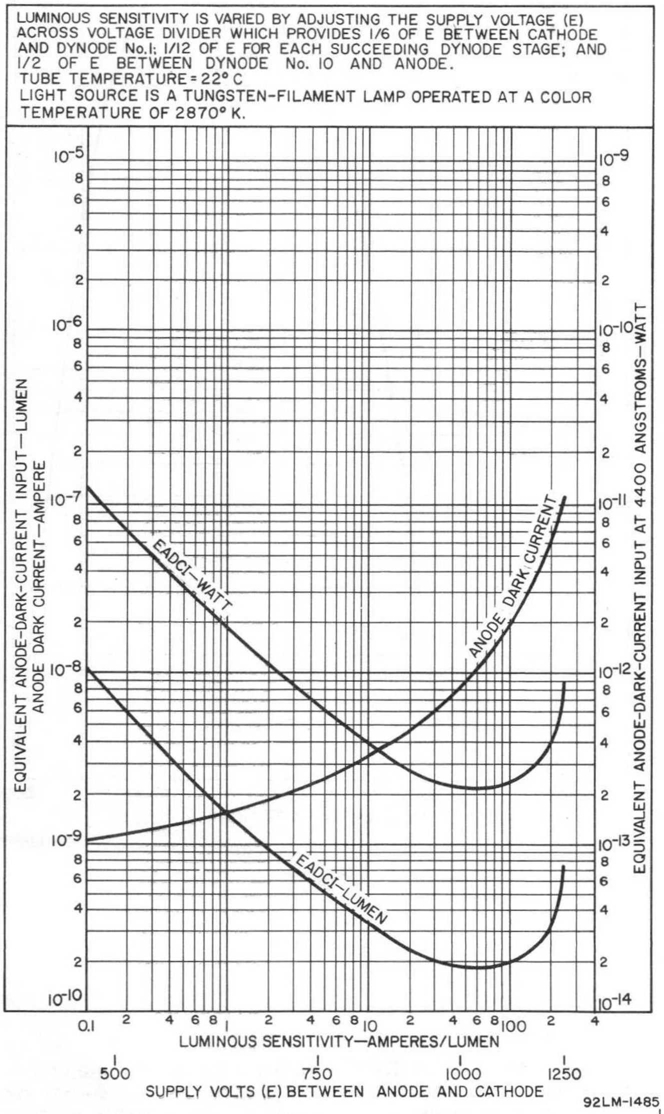


Fig. 6

Typical anode dark current as a function of luminous sensitivity at a temperature of +22° C is shown in *Fig.6.*

A *temporary increase in anode dark current* by as much as 2 orders of magnitude may occur if these tubes are exposed momentarily to high-intensity ultraviolet radiation from sources such as fluorescent room lighting even though voltage is not applied to the tubes. The increase in dark current may persist for a period of 24 to 48 hours following such irradiation.

The *use of a refrigerant,* such as dry ice, to cool the 6199 is recommended in those applications where maximum current amplification with minimum dark current is required.

The *equivalent noise input as a function of the temperature* of the 6199 is shown in *Fig.7.*

TYPICAL ENI CHARACTERISTICS

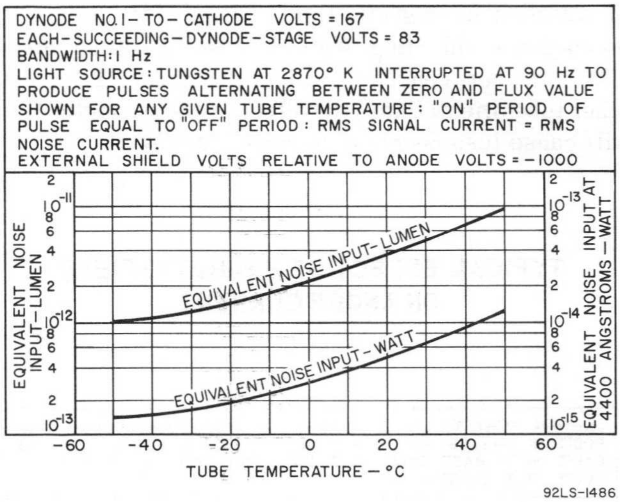


Fig. 7

Shielding:

Electrostatic and/or magnetic shielding of the 6199 may be necessary.

An *external electrostatic shield,* in contact with the sides of the glass envelope and connected to a negative dc potential essentially the same as that of the photocathode, should be employed in those applications where it is desired to reduce the equivalent noise input of the 6199 to a minimum.

The application of high voltage, with respect to cathode, to insulating or other materials supporting or shielding the 6199 at the photocathode end of the tube should not be permitted unless such materials are chosen to limit leakage current to the tube envelope to 1 x 10^{-12} ampere or less. In addition to increasing dark current and noise output because of voltage gradients developed across the bulb wall, such high voltage may produce minute leakage current to the cathode through the tube envelope and insulating materials which can permanently damage the tube.

It is to be noted that the use of an external magnetic and/or electrostatic shield at high negative potential presents a safety hazard unless the shield is connected through a high impedance in the order of 10 megohms to the negative-potential source. If the shield is not so connected, *extreme care should be observed in providing adequate safeguards to prevent personnel from coming in contact with the high potential of the shield.*

Magnetic shielding of the 6199 is necessary if it is operated in the presence of strong magnetic fields. The curve in *Fig.8* shows the effect on anode current of variation in magnetic-field strength for a tube with no magnetic shielding. With increase in voltage above 100 volts between cathode and dynode No.1, or with other tube orientations, the effect of the magnetic field will cause less decrease in anode current.

TYPICAL EFFECT OF MAGNETIC FIELD ON ANODE CURRENT

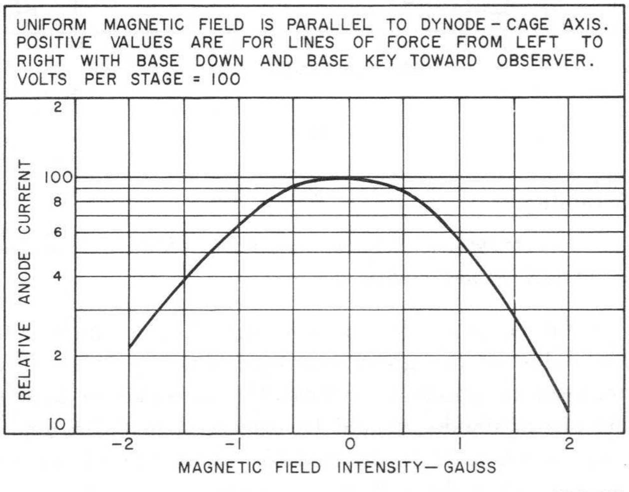


Fig. 8

Adequate *light shielding* should be provided to prevent extraneous light from reaching any part of the 6199.

SPECTRAL ENERGY DISTRIBUTION OF 2870° K LIGHT SOURCE AFTER PASSING THROUGH BLUE FILTER

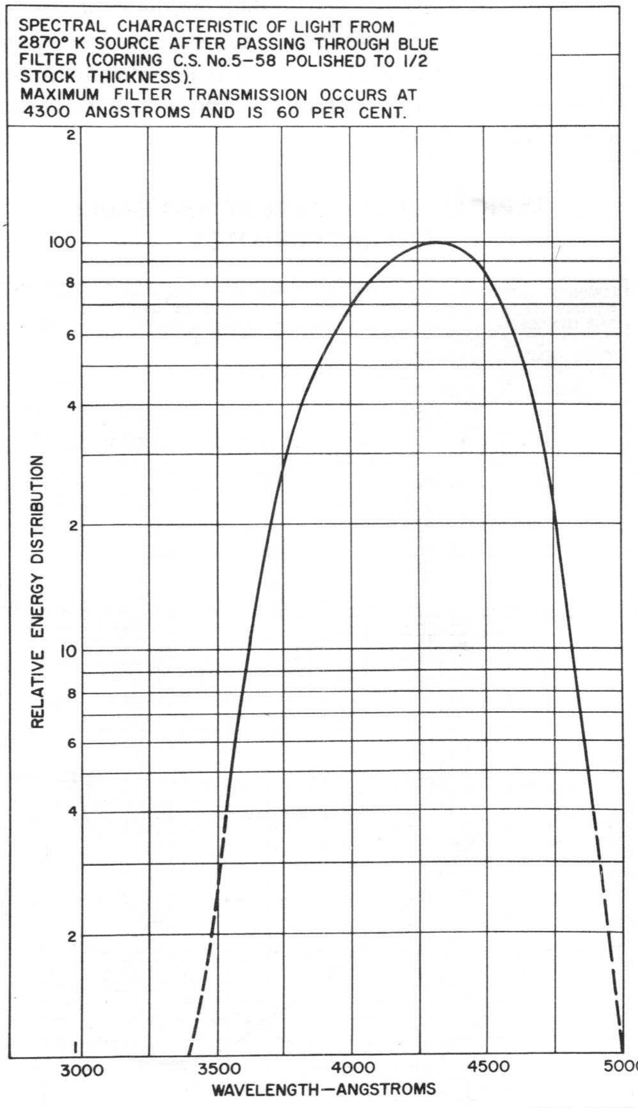


Fig. 9

TYPICAL VOLTAGE-DIVIDER ARRANGEMENT FOR TYPE 6199

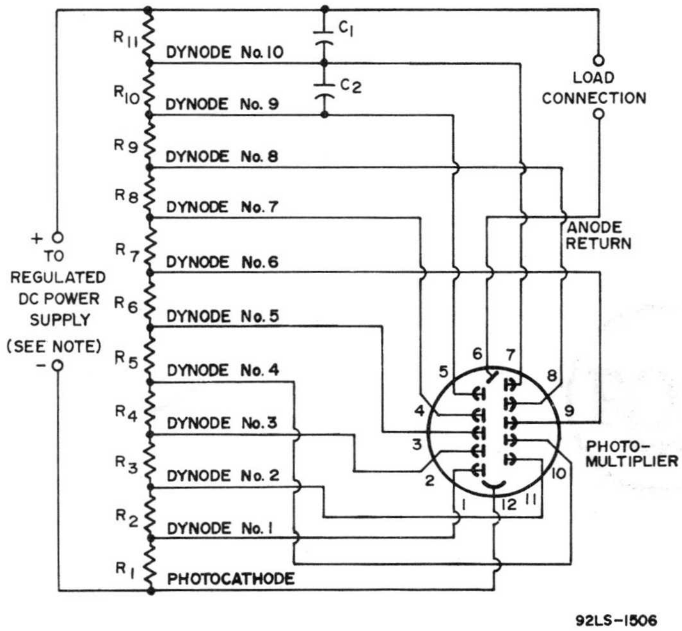


Fig. 10

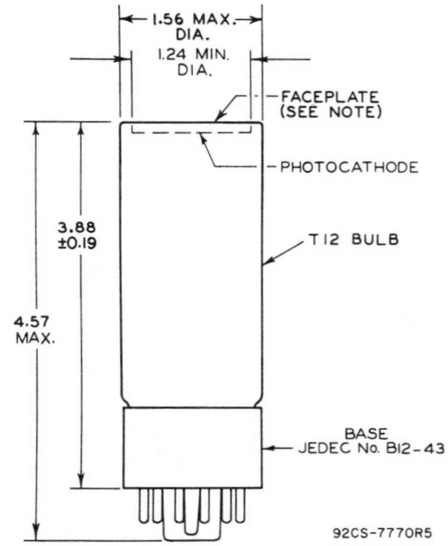
NOTE: Adjustable between approximately 500 and 1250 volts dc.

C_1, C_2: 0.01 µF, non-inductive type, 400 volts (dc working) – Values dependent on amplitude and duration of pulse. (See page 4.)

R_1: 91,000 ohms, 2 watts (See *Operating Voltages* page 4.)

R_2 through R_{11}: 47,000 ohms, 1 watt (See *Operating Voltages* page 4.)

DIMENSIONAL OUTLINE

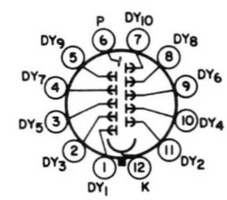


DIMENSIONS IN INCHES

NOTE: Deviation from flatness within the 1.24"-diameter area will not exceed 0.010" from peak to valley.

℄ of bulb will not deviate more than 2° in any direction from the perpendicular erected at the center of bottom of the base.

BASING DIAGRAM
Bottom View



DIRECTION OF RADIATION: INTO END OF BULB

12AE

Pin 1: Dynode No.1	Pin 7: Dynode No.10
Pin 2: Dynode No.3	Pin 8: Dynode No.8
Pin 3: Dynode No.5	Pin 9: Dynode No.6
Pin 4: Dynode No.7	Pin 10: Dynode No.4
Pin 5: Dynode No.9	Pin 11: Dynode No.2
Pin 6: Anode	Pin 12: Photocathode

RCA

RCA-6342A

PHOTOMULTIPLIER TUBE

1.68" Min. Diameter Curved Circular Semitransparent Photocathode	Fast Response 10-Stage, Head-On Type, Flat Faceplate S-11 Response	2.31" Max. Diameter 5.81" Max. Length

RCA-6342A is a 10-stage, head-on type of photomultiplier tube intended for use in scintillation counters for the detection and measurement of nuclear radiation, and in other applications involving low-level light sources.

The design of the 6342A includes a semitransparent photocathode on the curved inner surface of the face end of the bulb having a minimum useful diameter of 1.68"; a face with a flat surface to facilitate the mounting of flat scintillators; and ten electrostatically focused dynode stages.

The spectral response of the 6342A covers the range from about 3000 to 6500 angstroms, as shown in Fig.2. Maximum response occurs at approximately 4400 angstroms. The 6342A, therefore, has high sensitivity to the blue and less sensitivity to the red regions of the visible spectrum.

DATA

General:

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 angstroms
Cathode, Semitransparent	Cesium-Antimony
Shape	Curved, Circular
Minimum area	2.2 sq. in.
Minimum diameter	1.68 in.
Window	Lime Glass (Corning[a] No.0080), or equivalent
Index of refraction	1.51
Dynode Material	Copper-Beryllium
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.10	4.4 pf
Anode to all other electrodes	7.0 pf
Maximum Overall Length	5.81"
Seated Length	4.87" ± 0.19"
Maximum Diameter	2.31"
Bulb	T16
Base	Medium-Shell Diheptal 14-Pin, (JEDEC Group 5, No.B14-38), Non-hygroscopic
Socket	Loranger[b] No.2274, or equivalent
Magnetic Shield	Millen[c] No.80802B, or equivalent
Operating Position	Any
Weight (Approx.)	5.2 oz

Maximum Ratings, *Absolute-Maximum Values:*[d]

Supply Voltage Between Anode and Cathode (DC or Peak AC)	1500 max.	volts
Supply Voltage Between Dynode No.10 and Anode (DC or Peak AC)	250 max.	volts
Supply Voltage Between Dynode No.1 and Cathode (DC or Peak AC)	400 max.	volts
Supply Voltage Between Focusing Electrode and Cathode (DC or Peak AC)	400 max.	volts
Average Anode Current[e]	2 max.	ma
Ambient Temperature	75 max.	°C

Characteristics Range Values for Equipment Design:

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode. Focusing-electrode voltage is adjusted to that value between 10 and 60 per cent of dynode No.1 potential (referred to cathode) which provides maximum anode current.

With E = 1250 volts (Except as noted)

	Min.	*Typical*	*Max.*		
Sensitivity:					
Radiant at 4400 angstroms	-	2.5×10^{4}	-	a/w	←
Cathode radiant at 4400 angstroms	-	0.064	-	a/w	
Luminous:					
At 0 cps[f]	15	31	200	a/lm	←
With dynode No.10 as output electrode[g]	-	22	-	a/lm	←
Cathode luminous:					
With tungsten light source[h]	5×10^{-5}	8×10^{-5}	-	a/lm	
With blue light source[j]	5×10^{-8}	-	-	a	
Current Amplification	-	3.9×10^{5}	-		←
Equivalent Anode-Dark-Current Input[k]	-	2×10^{-10}[m]	2×10^{-9}[m]	lm	
	-	2.5×10^{-13}[n]	2.5×10^{-12}[n]	w	
Equivalent Noise Input[p]	-	7×10^{-12}	1.7×10^{-11}	lm	
	-	8.7×10^{-15}[q]	2.1×10^{-14}[q]	w	
Anode-Pulse Rise Time[r]	-	3×10^{-9}	-	sec	
Greatest Delay Between Anode Pulses:					
Due to position from which electrons are simultaneously released within a circle centered on tube face having a diameter of —					
1-1/8"	-	1.3×10^{-9}[s]	-	sec	
1-9/16"	-	4×10^{-9}[s]	-	sec	

→ Indicates a change.

a Made by Corning Glass Works, Corning, New York.

b Made by Loranger Manufacturing Corporation, 36 Clark Street, Warren, Pennsylvania.

c Made by James Millen Manufacturing Company, 150 Exchange Street, Malden 48, Massachusetts.

d The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices. Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

e Averaged over any interval of 30 seconds maximum.

f Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K and a light input of 10 microlumens is used.

g An output current of opposite polarity to that obtained at the anode may be provided by using dynode No.10 as the output electrode. With this arrangement, the load is connected in the dynode-No.10 circuit and the anode serves only as a collector. The average anode characteristics shown in Fig.4 do not apply when dynode number 10 is used as the output electrode.

h Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K. The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

j Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, Glass Code No.5113 polished to 1/2 stock thickness—Manufactured by the Corning Glass Works, Corning, New York) from a tungsten-filament lamp operated at a color temperature of 2870° K. The value of light flux incident on the filter is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

k For maximum signal-to-noise ratio, operation with a supply voltage (E) below 1250 volts is recommended.

m Measured at a tube temperature of 25° C and with a supply voltage (E) adjusted to give a luminous sensitivity of 20 amperes per lumen. Dark current may be reduced by use of a refrigerant.

n Determined at 4400 angstroms.

p Under the following conditions: Supply voltage (E) is as shown, 25° C tube temperature, external shield connected to cathode, bandwidth 1 cycle per second, tungsten-light source at a color temperature of 2870° K interrupted at a low audio-frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

q Determined under the same conditions shown under (p) except that use is made of a monochromatic source having radiation at 4400 angstroms.

r Measured between 10 per cent and 90 per cent of maximum anode-pulse height. This anode-pulse rise time is primarily a function of transit-time variations in the multiplier stages and is measured under conditions with an incident-light spot approximately 1 millimeter in diameter centered on the photocathode.

s These values also represent the difference in time of transit between the photocathode and dynode No.1 for electrons simultaneously released from the center and from the periphery of the specified areas.

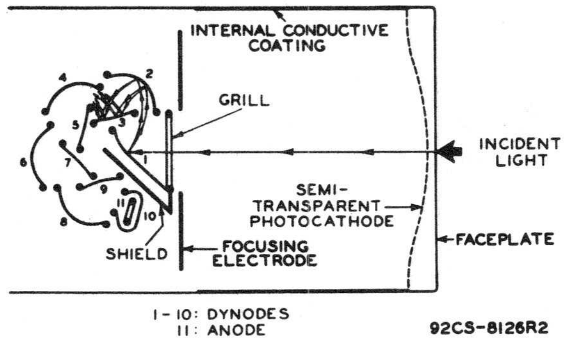


Fig.1 - Schematic Arrangement of Type 6342A Structure.

OPERATING CONSIDERATIONS

The use of an *average anode current* well below the maximum rated value of 2 milliamperes is recommended when stability of operation is important.

Electrostatic and/or magnetic shielding of the 6342A may be necessary. When a shield is used it must be connected to cathode potential.

The application of high voltage, with respect to cathode, to insulating or other materials supporting or shielding the 6342A at the photocathode end of the tube should not be permitted unless such materials are chosen to limit leakage current to the tube envelope to 1×10^{-12} ampere or less. In addition to increasing dark current and noise output because of voltage gradients developed across the bulb wall, such high voltage may produce minute leakage current to the cathode through the tube envelope and insulating materials which can permanently damage the tube.

A typical voltage-divider arrangement for use with the 6342A is shown in Fig.6. Recommended resistance values for the voltage divider range from 10,000 ohms per stage to 1,000,000 ohms per stage. The choice of resistance values for the voltage-divider network is usually a compromise. If low values of resistance per stage are utilized, the power drawn from the regulated power supply and the required wattage rating of the resistors increase. Phototube noise may also increase due to heating if the divider network is near the photocathode. The use of resistance values near 1 megohm per stage may cause deviation from linearity if the voltage-divider current is not maintained at a value several times that of the maximum value of anode current, and may limit anode-current response to pulsed light. The latter effect may be reduced by connecting non-inductive type capacitors between the tube socket terminals for dynodes No.7 and No.8, dynodes No.8 and No.9, dynodes No.9 and No.10, and between dynode No.10 and anode. In addition to non-linearity and pulse-limiting effects, the use of resistance values exceeding 1 megohm per stage make the 6342A more susceptible to leakage effects between terminals with possible resulting deviation in interstage voltage leading to a loss of current amplification.

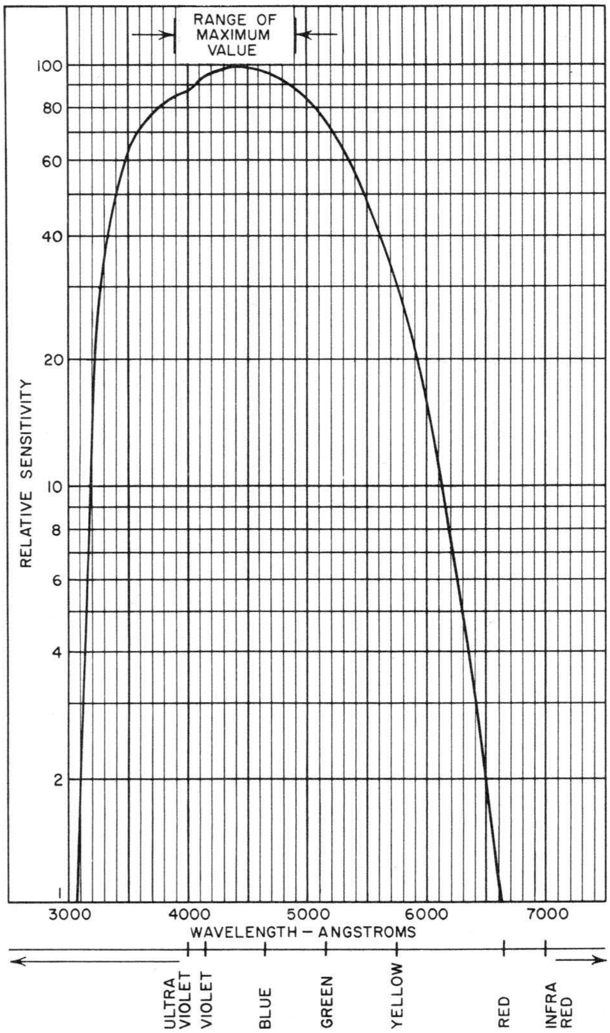


Fig.2 - Semi-Logarithmic Presentation of S-11 Response.

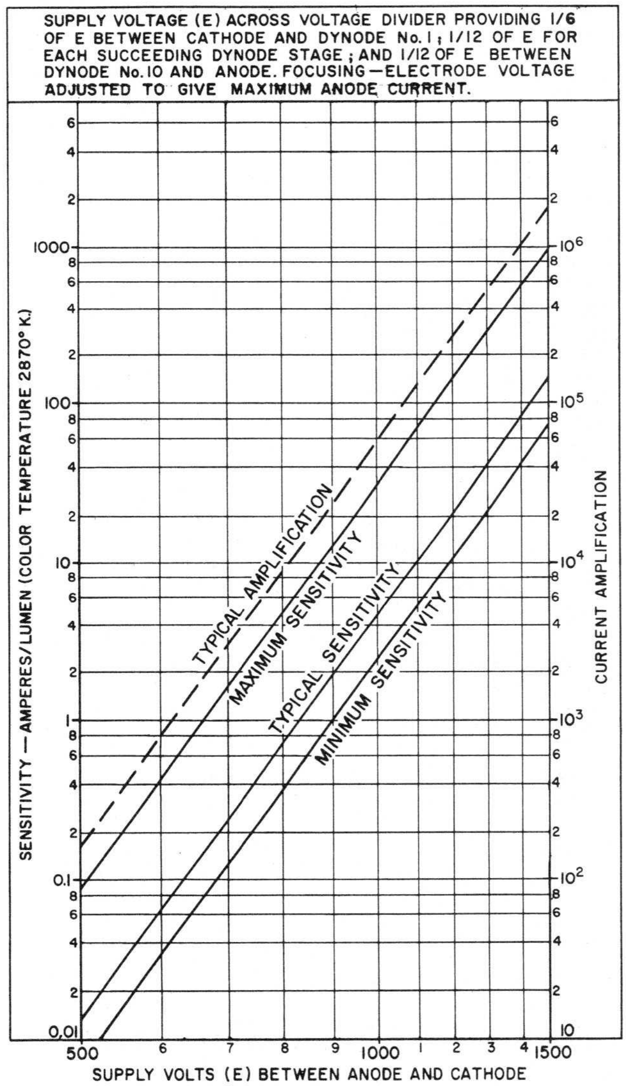


Fig.3 - Characteristics of Type 6342A.

The high voltages at which the 6342A is operated are very dangerous. Before any part of the circuit is touched, the power supply switch should be turned off and both terminals of any capacitors grounded.

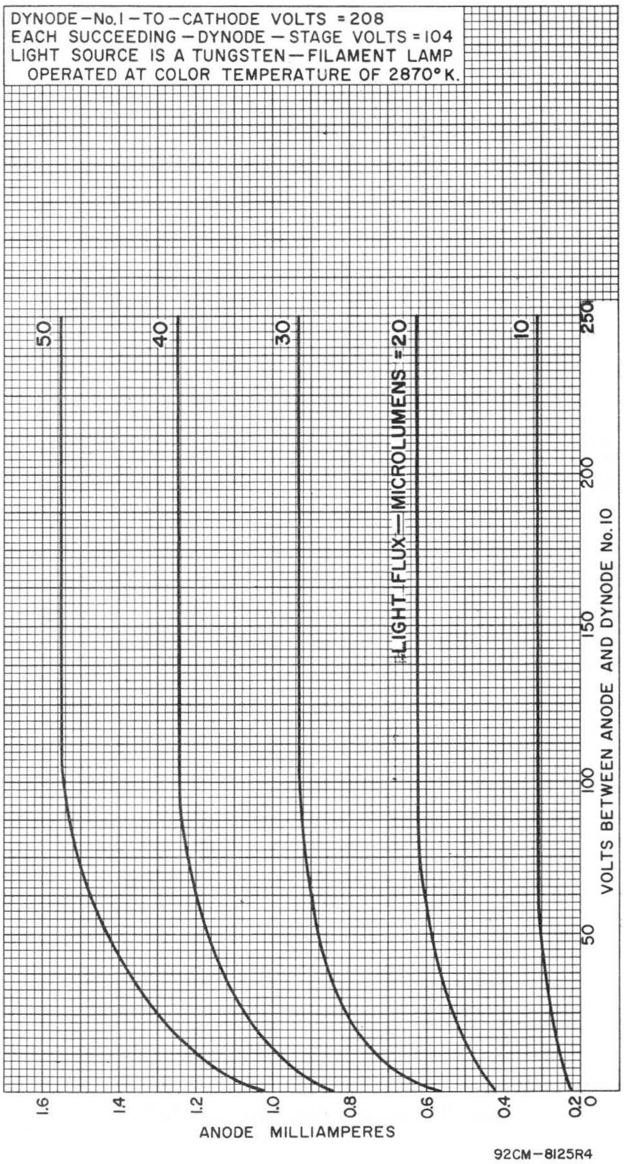


Fig.4 - Average Anode Characteristics of Type 6342A.

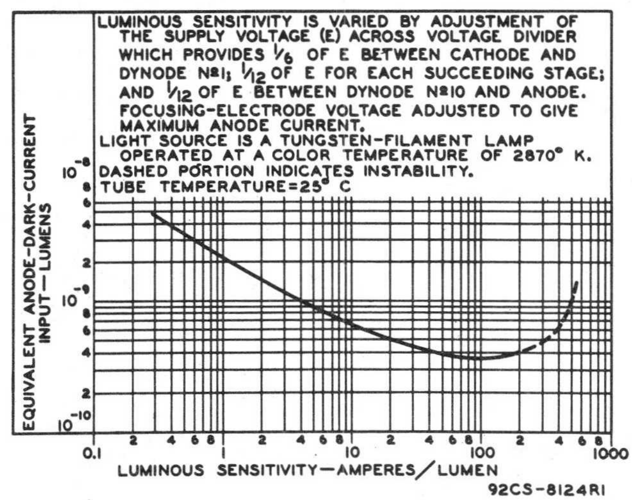
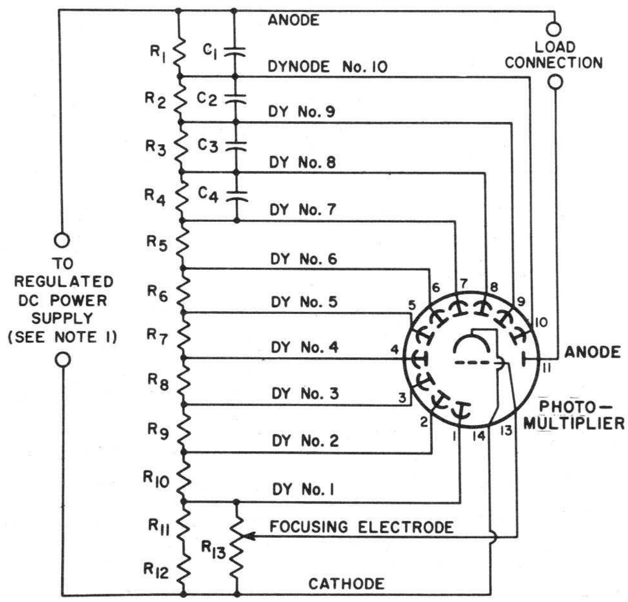


Fig.5 - Typical Anode-Dark-Current Characteristic of Type 6342A.



C_1: 0.05 μf, non-inductive type, 400 volts (dc working)

C_2: 0.02 μf, non-inductive type, 400 volts (dc working)

C_3: 0.01 μf, non-inductive type, 400 volts (dc working)

C_4: 0.005 μf, non-inductive type, 400 volts (dc working)

R_1 through R_{12}: 33,000 ohms, 2 watts

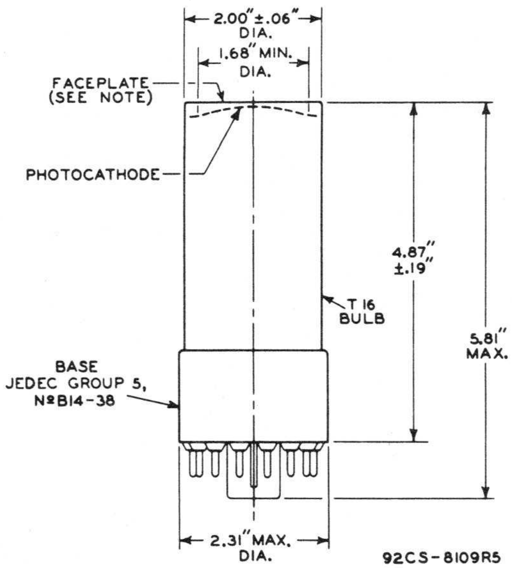
R_{13}: 2.5 megohms, 2 watts, adjustable

Note 1: Adjustable between approximately 500 and 1500 volts dc.

Note 2: Capacitors C_1 through C_4 should be connected at tube socket for optimum high-frequency performance.

Fig.6 - Typical Voltage-Divider Arrangement for Type 6342A.

DIMENSIONAL OUTLINE

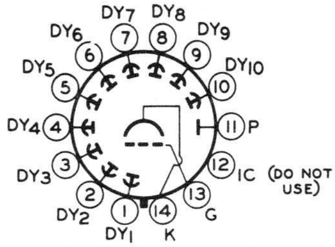


℄ OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF BOTTOM OF THE BASE.

NOTE: WITHIN 1.68" DIAMETER, DEVIATION FROM FLATNESS OF EXTERNAL SURFACE OF FACEPLATE WILL NOT EXCEED 0.010" FROM PEAK TO VALLEY.

BASING DIAGRAM
Bottom View

Pin 1: Dynode No.1
Pin 2: Dynode No.2
Pin 3: Dynode No.3
Pin 4: Dynode No.4
Pin 5: Dynode No.5
Pin 6: Dynode No.6
Pin 7: Dynode No.7
Pin 8: Dynode No.8



DIRECTION OF LIGHT: INTO END OF BULB

14AA

Pin 9: Dynode No.9
Pin 10: Dynode No.10
Pin 11: Anode
Pin 12: Internal Connection—Do Not Use
Pin 13: Focusing Electrode
Pin 14: Photocathode

RCA

RCA-6655A

PHOTOMULTIPLIER TUBE

10-Stage, Head-on Type
S-11 Spectral Response

RCA-6655A is a 10-stage, head-on, 2"-diameter type of photomultiplier tube intended for use in scintillation counters and for the detection and measurement of low-level radiation.

The spectral response of the 6655A, at the 10-percent points covers the approximate range from 3200 to 6100 angstroms as shown in *Fig.1*. Maximum relative response occurs at about 4400 angstroms, and peak cathode quantum efficiency at about 4200 angstroms.

SPECTRAL RESPONSE CHARACTERISTICS

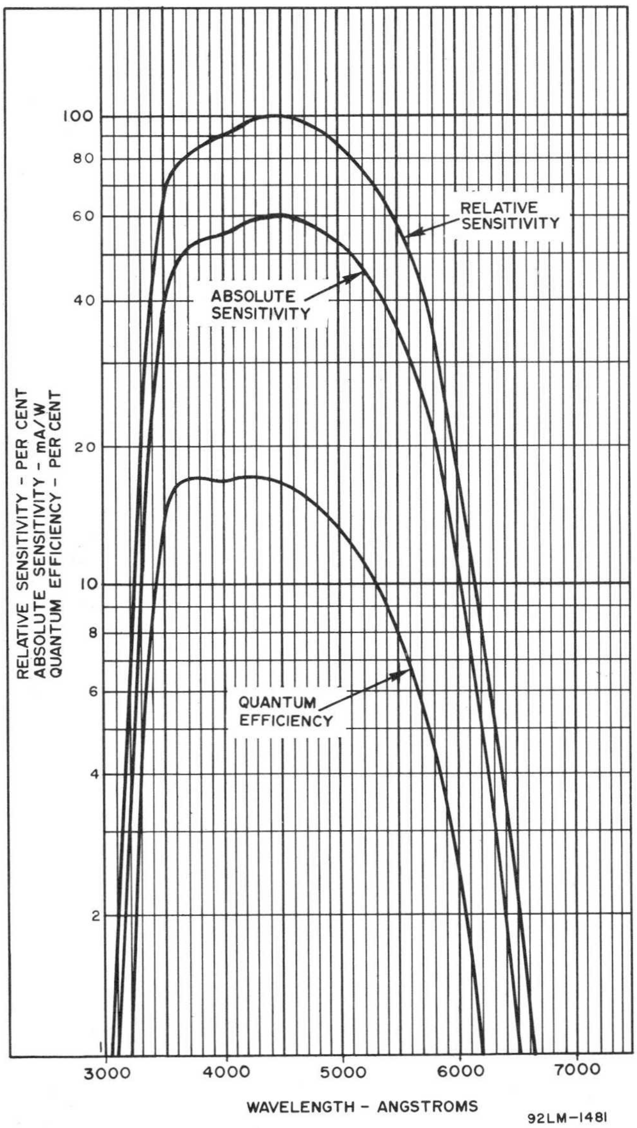


Fig.1

FEATURES

- **Fast Time Resolution Characteristics –**
  Anode-Pulse Rise Time:
  3.1 nanoseconds at 1250 volts
  Electron Transit Time:
  31 nanoseconds at 1250 volts
- **High Current Amplification –**
  1.6×10^6 at 1000 volts
- **Flat Faceplate for Ease in Scintillator Coupling**

DATA

General:

Spectral Response	S-11
Wavelength of Maximum Response	4400 ±500 angstroms
Cathode, Semitransparent	Cesium-Antimony
Shape	Curved-Circular
Minimum projected area	2.2 in^2
Minimum diameter	1.68 in
Window	Lime Glass, Corning[a] 0080, or equivalent
Shape	Plano-Concave
Index of refraction at 5893 angstroms	1.51
Dynodes:	
Substrate	Nickel
Secondary-Emitting Surface	Cesium-Antimony
Structure	Circular-Cage
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.10	4.4 pF
Anode to all other electrodes	7.0 pF
Maximum Overall Length	5.81 in
Seated Length	4.87 ±0.19 in
Maximum Diameter	2.31 in
Bulb	T16
Base	Medium-Shell Diheptal 14-Pin, (JEDEC Group 5, No.B14-38), Non-hygroscopic
Socket	Loranger[b] Part No.2274, or equivalent
Magnetic Shield	Millen[c] Part No.80802B, or equivalent
Operating Position	Any
Weight (Approx.)	5.2 oz

Maximum

DC Supply Voltage:			
Between anode and cathode	1250	max.	volts
Between anode and dynode No.10	250	max.	volts
Between consecutive dynodes	200	max.	volts
Between dynode No.1 and cathode	300	max.	volts
Between focusing electrode and cathode	300	max.	volts
Average Anode Current[e]	0.75	max.	mA
Ambient Temperature[f]	75	max.	°C

Characteristics Range Values for Equipment Design:

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode. Focusing-electrode voltage is adjusted to that value between 10 and 60 per cent of dynode No.1 potential (referred to cathode) which provides maximum anode current.

With E = 1000 volts (Except as noted)

	Min.	Typical	Max.	
Sensitivity:				
Radiant[g] at 4400 angstroms	–	9.6×10^{4}	–	A/W
Cathode radiant[h] at 4400 angstroms	–	0.061	–	A/W
Luminous[i]	10	120	300	A/lm
Cathode luminous:				
With tungsten light source[k]	4×10^{-5}	7.6×10^{-5}	–	A/lm
With blue light source[m]	4×10^{-8}	–	–	A
Cathode quantum efficiency at 4200 angstroms	–	17	–	%
Current Amplification	–	1.6×10^{6}	–	
Equivalent Anode-Dark-Current Input[n]	–	3.0×10^{-10} [p]	2×10^{-9} [p]	lm
	–	3.7×10^{-13} [q]	2.5×10^{-12} [q]	W
Anode Dark Current[n,p]	–	6×10^{-9}	–	A
Equivalent Noise Input[r]	–	8×10^{-13}	2.7×10^{-11}	lm
	–	1×10^{-15} [q]	3.4×10^{-14} [q]	W
Anode-Pulse Rise Time[s]	–	3.4×10^{-9}	–	sec
Electron Transit Time[t]	–	3.4×10^{-8}	–	sec

[a] Made by Corning Glass Works, Corning, New York.

[b] Made by Loranger Manufacturing Corporation, 36 Clark Street, Warren, Pennsylvania.

[c] Made by James Millen Manufacturing Company, 150 Exchange Street, Malden 48, Massachusetts.

[d] The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices. Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[e] Averaged over any interval of 30 seconds maximum.

[f] Tube operation at room temperature or below is recommended.

[g] This value is calculated from the typical value for luminous sensitivity using a conversion factor of 804 lumens per watt.

[h] This value is calculated from the typical value for cathode luminous sensitivity using a conversion factor of 804 lumens per watt.

[i] Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K and a light input of 10 microlumens is used.

[k] Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K. The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[m] Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, Glass Code No.5113 polished to ½ stock thickness—Manufactured by the Corning Glass Works, Corning, New York) from a tungsten-filament lamp operated at a color temperature of 2870° K. The value of light flux incident on the filter is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[n] Measured at a tube temperature of 22° C. Dark current may be reduced by use of a refrigerant.

[p] Measured with supply voltage (E) adjusted to give a luminous sensitivity of 20 amperes per lumen. Dark current is measured with no incident light on tube.

[q] At 4400 angstroms: This value is calculated from the rating in lumen using a conversion factor of 804 lumens per watt.

[r] Under the following conditions: Supply voltage (E) is as shown, 22° C tube temperature, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of 2870° K interrupted at a low audio-frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[s] Measured between 10 per cent and 90 per cent of maximum anode-pulse height. This anode-pulse rise time is primarily a function of transit time variation and is measured under conditions with the incident light fully illuminating the photocathode.

[t] The electron transit time is the time interval between the arrival of a delta function light pulse at the entrance window of the tube and the time at which the output pulse at the anode terminal reaches peak amplitude. The transit time is measured under conditions with the incident light fully illuminating the photocathode.

OPERATING CONSIDERATIONS

Operating Stability:

The *operating stability* of the 6655A is dependent on the magnitude of the anode current. The use of an average anode current well below the maximum rated value of 0.75 milliampere is recommended when stability of operation is important. When maximum stability is required, average anode current should not exceed 10 microamperes.

SCHEMATIC ARRANGEMENT OF STRUCTURE

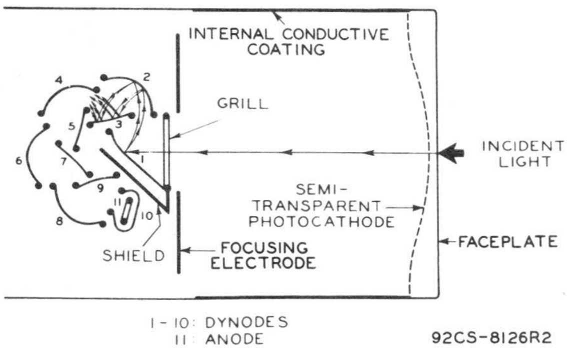


Fig.2

Operating Voltages:

In general, the *operating potential between anode and cathode* should not be less than 500 volts.

The voltage between dynode No.10 and anode should be kept as low as will permit operation over the knee of the anode characteristic curves shown in *Fig.5*. With low operating voltage between dynode No.10 and anode, the ohmic leakage current to the anode is reduced. Operation over the knee occurs in the approximate range of 50 to 100 volts for the light level ranges shown in *Fig.5*. However, when high pulse currents are drawn, saturation results from space-charge limitations and higher voltage will be required. To obtain the suggested operating voltage between dynode No.10 and anode, it is necessary to increase the supply voltage between these electrodes by an amount equal to the voltage drop across a particular output load.

In *applications where minimum electron transit time spread* and more efficient collection of photoelectrons from cathode by dynode No.1 are desired, the potential between cathode and dynode No.1 may be increased to the rated maximum value of 300 volts.

TYPICAL TIME-RESOLUTION CHARACTERISTICS

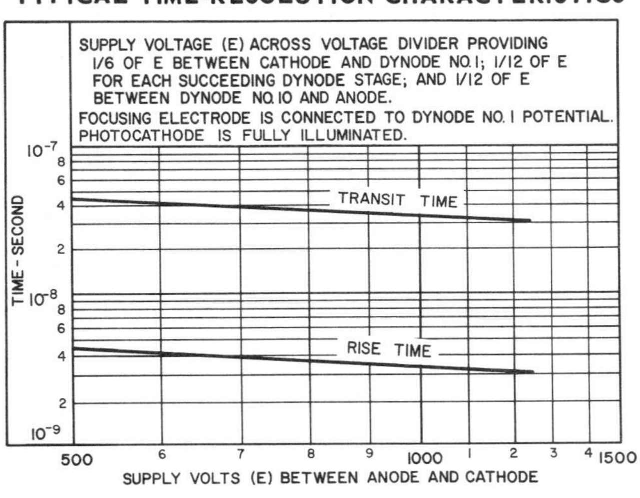


Fig.3

The *operating voltages* for the 6655A can be supplied by spaced taps on a voltage divider across a regulated dc power supply. A typical voltage-divider arrangement for use with the 6655A is shown in *Fig.8*. The choice of resistance values for the voltage-divider string is usually a compromise. If low values of resistance per stage are utilized, the power drawn from the supply and the required wattage rating of the resistors increase. Phototube noise may also increase, due to heating, if the divider network is mounted near the tube. The use of high values of resistance per stage may cause deviation from linearity, if the voltage-divider current is not maintained at a value of at least 10 times that of the maximum average anode current, and may limit anode current response to pulsed light.

TYPICAL SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS

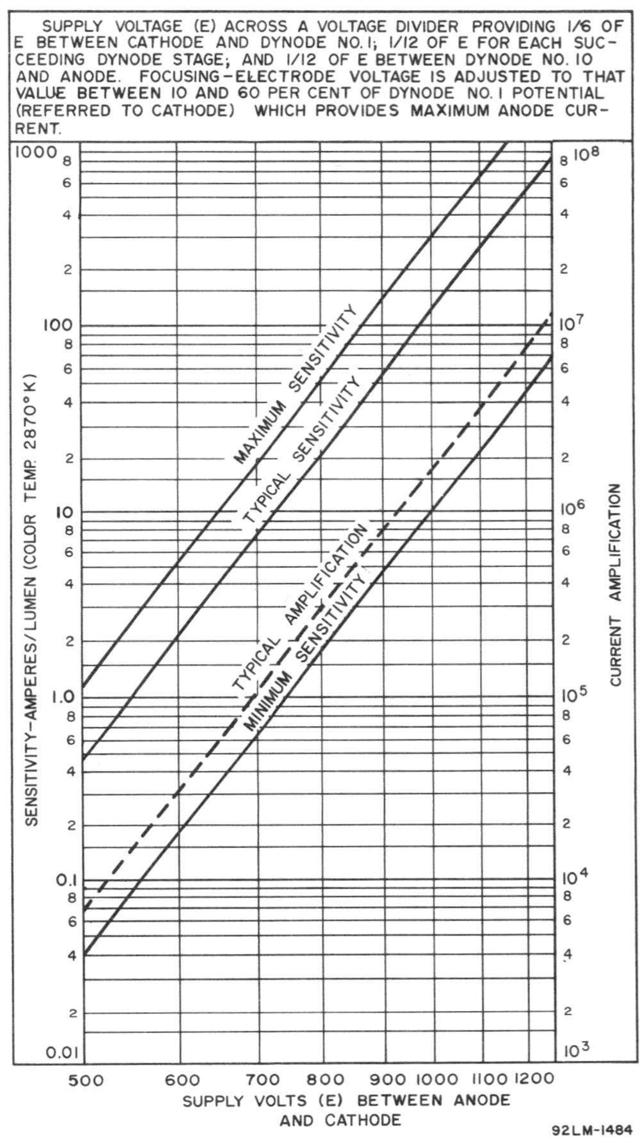


Fig.4

When *the ratio of peak anode current to average anode current is high,* noninductive high-quality capacitors should be employed across the latter stages of the tube. The values of these capacitors should be chosen so that sufficient charge is available to prevent a change of more than a few per cent in the interstage voltages during the pulse duration.

The *high voltages at which the 6655A is operated* are very dangerous. Care should be taken in the design of apparatus to prevent the operator from coming in contact with these high voltages. Precautions should include the enclosure of high-potential terminals and the use of interlock switches to break the primary circuit of the high-voltage power supply when access to the apparatus is required.

In the use of the 6655A, as with other tubes requiring high voltages, it should always be remembered that these high voltages may appear at points in the circuit which are normally at low potential, because of defective circuit parts or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned off and both terminals of any capacitors grounded.

Dark Current:

A very small *anode dark current* is observed when voltage is applied to the electrodes of the 6655A in complete darkness. Among the components contributing to dark current are ohmic leakage between the anode

TYPICAL ANODE CHARACTERISTICS

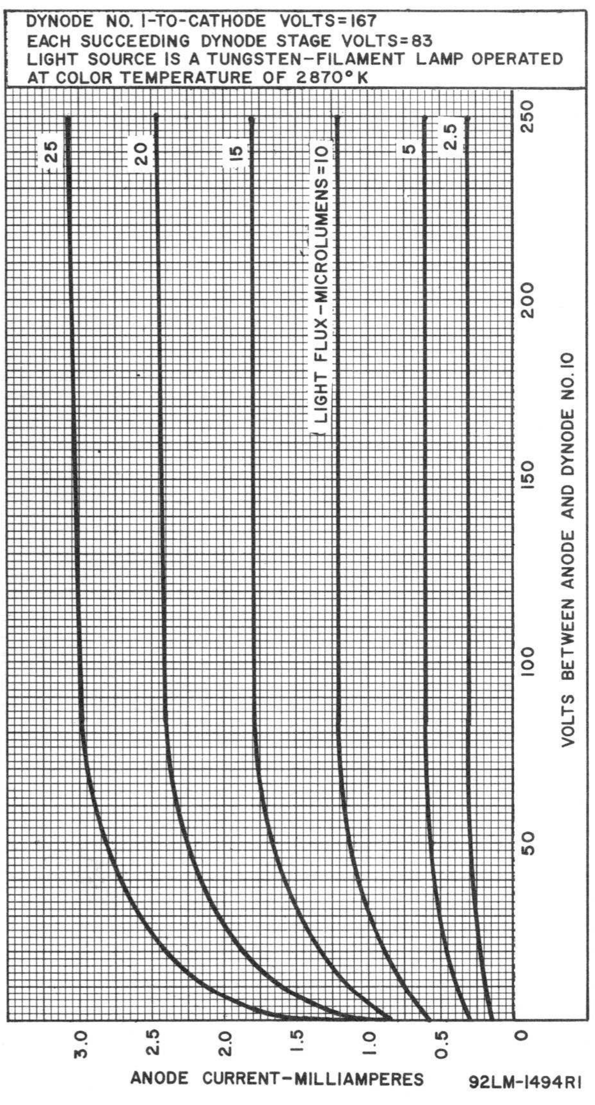


Fig.5

TYPICAL DARK CURRENT AND EADCI CHARACTERISTICS

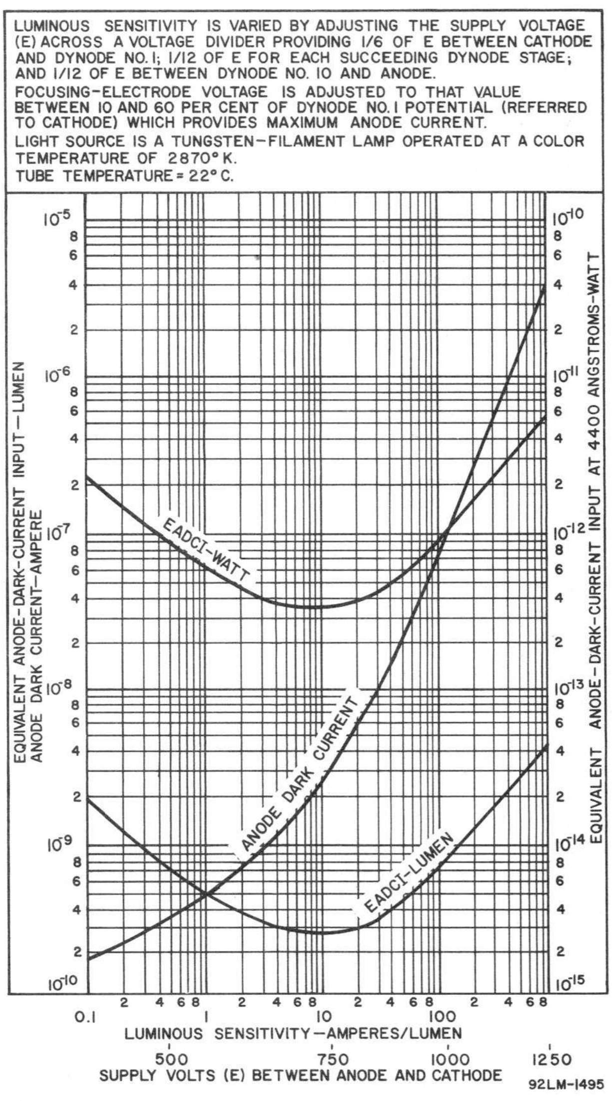


Fig.6

and adjacent elements and pulses produced by electrons thermionically released from the cathode, secondary electrons released by ionic bombardment of the dynodes, support rods, or cathode, and by cold emission from the electrodes.

For *optimum tube performance* it is recommended that the 6655A be operated at or below room temperature. Dark current may be reduced by use of a refrigerant such as dry ice.

A *temporary increase in anode dark current* by as much as 2 orders of magnitude may occur if the 6655A is exposed momentarily to high-intensity ultraviolet radiation from sources such as fluorescent room lighting even though voltage is not applied to the tube. The increase in dark current may persist for a period of 24 to 48 hours following such irradiation.

Shielding:

Electrostatic and/or magnetic shielding of the 6655A may be necessary.

An *external electrostatic shield,* in contact with the sides of the glass envelope and connected to a negative dc potential essentially the same as that of the photocathode, should be employed in those applications where it is desired to reduce the equivalent noise input of the 6655A to a minimum.

The application of high voltage, with respect to cathode, to insulating or other materials supporting or shielding the 6655A at the photocathode end of the tube should not be permitted unless such materials are chosen to limit leakage current to the tube envelope to 1 x 10^{-12} ampere or less. In addition to increasing dark current and noise output because of voltage gradients developed across the bulb wall, such high voltage may produce minute leakage current to the cathode through the tube envelope and insulating materials which can permanently damage the tube.

Magnetic shielding of the 6655A is necessary if it is operated in the presence of strong magnetic fields.

Adequate *light shielding* should be provided to prevent extraneous light from reaching any part of the 6655A.

It is to be noted that the use of an external magnetic and/or electrostatic shield at high negative potential presents a safety hazard unless the shield is connected through a high impedance in the order of 10 megohms to the negative-potential source. If the shield is not so connected, *extreme care should be observed in providing adequate safeguards to prevent personnel from coming in contact with the high potential of the shield.*

SPECTRAL ENERGY DISTRIBUTION OF 2870° K LIGHT SOURCE AFTER PASSING THROUGH BLUE FILTER

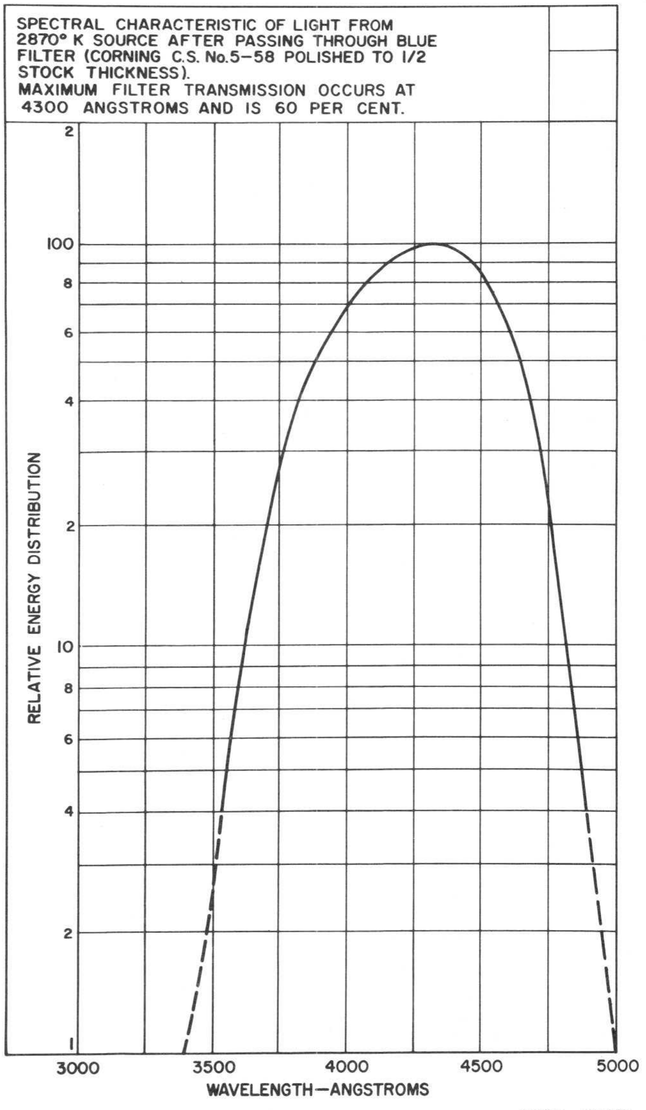


Fig.7

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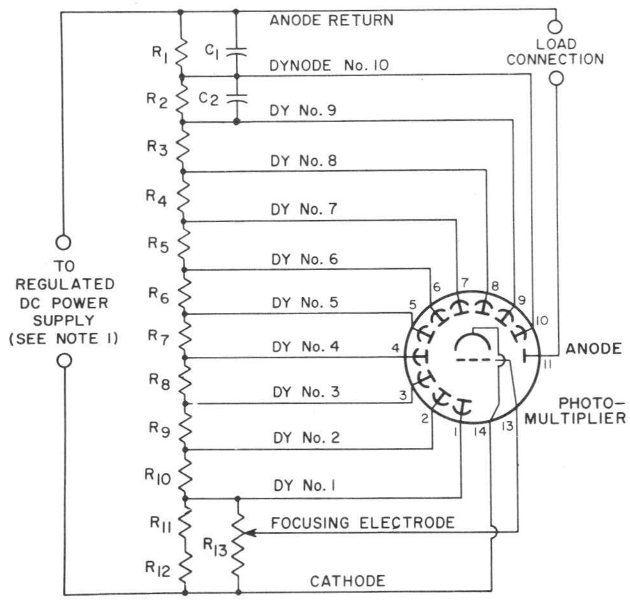
TYPICAL VOLTAGE DIVIDER ARRANGEMENT



92LS-1487

Fig.8

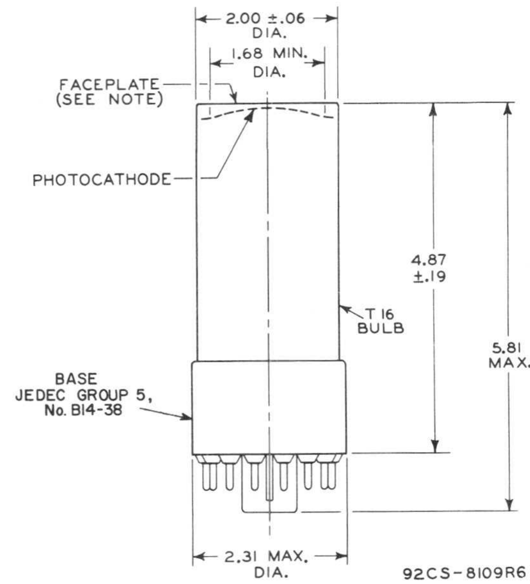
C_1, C_2: 0.01 µF non-inductive type, 400 volts (dc working)— Values dependent on amplitude and duration of pulse. (See page 4.)

R_1 through R_{12}: 33,000 ohms, 2 watts (See Operating Voltages - page 3.)

R_{13}: 2.5 megohms, 2 watts, adjustable (See Operating Voltages - page 3.)

Note 1: Adjustable between approximately 500 and 1250 volts dc.

DIMENSIONAL OUTLINE



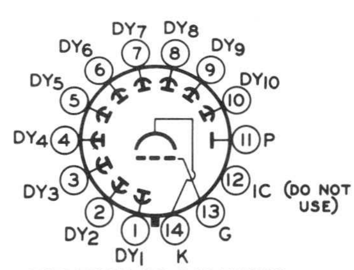
DIMENSIONS IN INCHES

℄ of bulb will not deviate more than 2° in any direction from the perpendicular erected at the center of bottom of the base.

Note: Within 1.68" diameter, deviation from flatness of external surface of faceplate will not exceed 0.010" from peak to valley.

BASING DIAGRAM
Bottom View

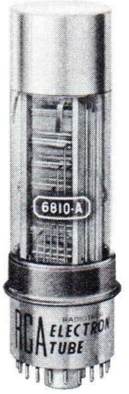
Pin 1: Dynode No.1
Pin 2: Dynode No.2
Pin 3: Dynode No.3
Pin 4: Dynode No.4
Pin 5: Dynode No.5
Pin 6: Dynode No.6
Pin 7: Dynode No.7
Pin 8: Dynode No.8



DIRECTION OF RADIATION: INTO END OF BULB

14AA

Pin 9: Dynode No.9
Pin 10: Dynode No.10
Pin 11: Anode
Pin 12: Internal Connection - Do not use
Pin 13: Focusing Electrode
Pin 14: Photocathode



H-844

Photomultiplier Tube

RCA-6810A

2"-Diameter, 14-Stage, Head-On Type Having S-11 Spectral Response.

RCA-6810A is a 2"-diameter, 14-stage, photomultiplier tube having S-11 spectral response and high-stability copper-beryllium dynodes. It is intended for use in scintillation counting and other low-level light detection and measurement applications.

- **Quantum Efficiency (Typical):**
  16% at 4200 angstroms
- **Copper-Beryllium Dynodes for High Stability**
- **Flat Entrance Window**
- **1.68" Minimum Diameter Photocathode**
- **Typical Time Resolution Characteristics:**
  Anode-Pulse Rise Time – 3.1 x 10^{-9} s at 2400 V
  Electron Transit Time – 4.4 x 10^{-8} s at 2400 V

Data

General:

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 Å
Cathode, Semitransparent	Cesium-Antimony
Minimum projected area	2.2 in^2 (14.2 cm^2)
Minimum diameter	1.68 in (4.2 cm)
Window	Corning[a] No.0080, or equivalent
Shape	Plano-Concave
Index of refraction at 4360 angstroms	1.523
Dynodes:	
Substrate	Copper-Beryllium
Secondary-Emitting Surface	Beryllium-Oxide
Structure	In-Line, Electrostatic-Focus Type
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.14	2.8 pF
Anode to all other electrodes	6 pF
Dynode No.14 to all other electrodes	7.5 pF
Maximum Overall Length	7.5 in (19 cm)
Seated Length	6.69 in (17 cm) ± 0.19 in
Maximum Diameter	2.38 in (6 cm)

Typical Spectral Response Characteristics

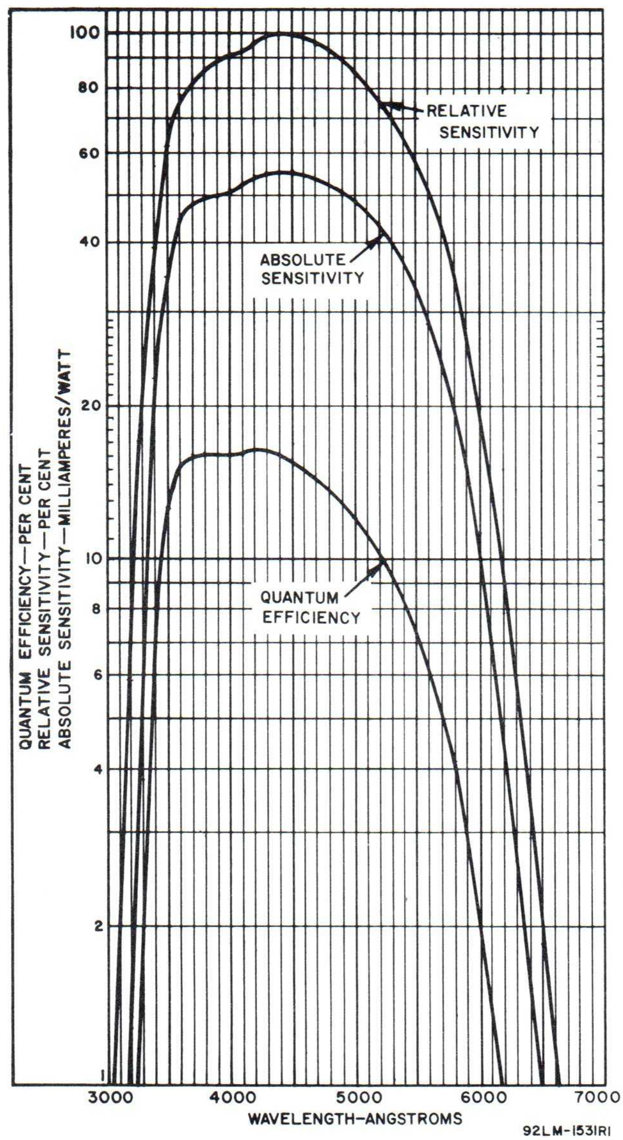


Figure 1

Data (Cont'd.)

Bulb T16

Base . . . . Small-Shell Bidecal 20-Pin, JEDEC No.B20-102

Socket . . . . Alden[b] Part 220FTC, or equivalent

Magnetic Shield . . . . . Millen[c] No.80802E, or equivalent

Operating Position . . . . Any

Weight (Approx.) . . . . 8 oz (226 g)

Maximum Ratings, *Absolute-Maximum Values:*[d]

DC Supply Voltage:

Between anode and cathode	2400 max.	V
Between anode and dynode No.14	400 max.	V
Between consecutive dynodes	500 max.	V
Between accelerating electrode and grid No.13	±500 max.	V
Between dynode No.1 and cathode	400 max.	V
Between focusing electrode and cathode .	400 max.	V
Average Anode Current[e]	2 max.	mA
Ambient Temperature[f]	75 max.	^{o}C

Characteristics Range Values for Equipment Design:

Voltage Distribution A, Table 1

With E = 2000 volts (Except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
➛Radiant[g] at 4400 angstroms .	–	3×10^{6}	–	A/W
➛Luminous[h] (2870^{o} K).	4.8×10^{2}	3.8×10^{3}	2×10^{4}	A/lm
Cathode Sensitivity:				
Radiant[i] at 4400 angstroms .	–	0.056	–	A/W
Luminous[k] (2870^{o} K).	5×10^{-5}	7×10^{-5}	–	A/lm
➛Current with blue light source[m] (2870^{o} K + C.S. No.5-58)	5×10^{-8}	7×10^{-8}	–	A
➛Quantum Efficiency at 4200 angstroms .	–	16	–	%
➛Current Amplification.	–	5.4×10^{7}	–	
➛Anode Dark Current[n].	–	1×10^{-6}	3×10^{-6}	A
➛Equivalent Anode Dark Current Input[n].	–	5×10^{-10}	1.5×10^{-9}	lm
	–	6.2×10^{-13}[p]	1.8×10^{-12}[p]	W
➛Equivalent Noise Input[q].	–	3.3×10^{-12}	–	lm
	–	4.1×10^{-15}[r]	–	W
➛Anode-Pulse Rise Time[s] at 2400 V. .	–	3.1×10^{-9}	–	s
➛Electron Transit Time[t] at 2400 V. .	–	4.4×10^{-8}	–	s

➛Indicates a change or addition.

[a] Made by Corning Glass Works, Corning, NY 14830.

[b] Made by Alden Products Co., 262 N. Main Street, Brockton, MA 02403.

[c] Made by James Millen Manufacturing Company, 150 Exchange Street, Malden, MA 02148.

[d] The maximum ratings in the tabulated data are established in accordance with the following definition of the Absolute-Maximum Rating System for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[e] Averaged over any interval of 30 seconds maximum.

[f] Tube operation at room temperature or below is recommended.

[g] This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 803 lumens per watt.

[h] Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870^{o} K and a light input of 0.1 microlumen is used.

[i] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 803 lumens per watt.

[k] Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870^{o} K. The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[m] Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, polished to 1/2 stock thickness—Manufactured by the Corning Glass Works, Corning, NY) from a tungsten-filament lamp operated at a color temperature of 2870^{o} K. The value of light flux incident on the filter is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[n] At a tube temperature of 22^{o} C. With supply voltage adjusted to give a luminous sensitivity of 2000 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant. Dark current is measured with incident light removed.

[p] At 4400 angstroms. These values are calculated from the EADCI values in lumens using a conversion factor of 803 lumens per watt.

[q] Under the following conditions: Tube temperature 22° C, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[r] At 4400 angstroms. This value is calculated from the ENI value in lumens using a conversion factor of 803 lumens per watt.

[s] Measured between 10 per cent and 90 per cent of maximum anode-pulse height. This anode-pulse rise time is primarily a function of transit time variation and is measured under conditions with the incident light fully illuminating the photocathode.

[t] The electron transit time is the time interval between the arrival of a delta function light pulse at the entrance window of the tube and the time at which the output pulse at the anode terminal reaches peak amplitude. The transit time is measured under conditions with the incident light fully illuminating the photocathode.

Table 1

Voltage Distribution

Between the following Electrodes: Cathode (K), Dynode (Dy), and Anode (P)	A 5.4% of Supply Voltage (E) multiplied by	B 6.06% of Supply Voltage (E) multiplied by
K - Dy1	2	♦
Dy1 - Dy2	1	1
Dy2 - Dy3	1	1
Dy3 - Dy4	1	1
Dy4 - Dy5	1	1
Dy5 - Dy6	1	1
Dy6 - Dy7	1	1
Dy7 - Dy8	1	1
Dy8 - Dy9	1	1
Dy9 - Dy10	1	1
Dy10 - Dy11	1	1
Dy11 - Dy12	1.25	1.25
Dy12 - Dy13	1.5	1.5
Dy13 - Dy14	1.75	1.75
Dy14 - P	2	2
Dy1 - P	–	16.5
K-P	18.5	–

Focusing electrode is connected to arm of potentiometer between cathode and dynode No. 1; the focusing electrode voltage is varied to give maximum anode current.

♦Cathode-to-dynode No. 1 voltage is maintained at 360 volts.

Operating Considerations

Terminal Connections

The base pins of the 6810A fit a bidecal 20-contact socket, such as Alden No.220FTC or equivalent.

The socket should be made of high-grade, low-leakage material.

Anode Current

The operating stability of the 6810A is dependent on the magnitude of the anode current. The use of an average anode current well below the maximum rated value of 2 milliamperes is recommended when stability of operation is important. When stability is of prime importance, the use of an average anode current of 10 microamperes or less, commensurate with satisfactory output signal, is recommended.

Dark Current

A very small anode dark current is observed when voltage is applied to the electrodes of the 6810A in complete darkness. Among the components contributing to dark current are ohmic leakage between the anode and adjacent elements and pulses produced by electrons thermionically released from the cathode, secondary electrons released by ionic bombardment of the dynodes, support rods, or cathode, and by cold emission from the electrodes.

Typical anode dark current and EADCI as a function of luminous sensitivity at a temperature of +22° C is shown in **Figure 5**.

A temporary increase in anode dark current by as much as 3 orders of magnitude may occur if the tube is exposed momentarily to high-intensity ultraviolet radiation from sources such as fluorescent room lighting even though voltage is not applied to the tube. The increase in dark current may persist for a period of 24 to 48 hours following such irradiation.

For optimum tube performance it is also recommended that the 6810A be operated at or below room temperature. Dark current may be reduced by use of a refrigerant such as dry ice.

Shielding

Electrostatic shielding of the tube is ordinarily required. When a shield is used, it must be connected to the cathode terminal. The application of high voltage, with respect to cathode, to insulating or other materials supporting or shielding the tube at the photocathode end should not be permitted unless such materials are chosen to limit leakage current to the tube envelope to 1 x 10^{-12} ampere or less.

In addition to increasing dark current and noise output because of voltage gradients developed across the bulb wall, such high voltage may produce minute leakage current to the cathode, through the tube envelope and insulating materials, which can permanently damage the tube.

Ambient Atmosphere

Operation or storage of this tube in environments where helium is present should be avoided. Helium may permeate through the tube envelope and may lead to eventual tube destruction.

Operating Voltages

In general, the operating potential between anode and cathode should not be less than 800 volts.

The operating voltage between dynode No.14 and anode should be kept as low as will permit operation over the knee of the anode characteristic curves shown in **Figure 6**. With low operating voltage between dynode No.14 and anode, the ohmic leakage current to the anode is reduced. Operation over the knee occurs in the approximate range of 50 to 75 volts for the light level range shown in **Figure 6**. Under high pulse current conditions, saturation due to space-charge limitations will occur and higher voltage will be required. To obtain the suggested operating voltage between dynode No.14 and anode, it is necessary to increase the supply voltage between these electrodes by an amount equal to the voltage drop across a particular output load.

To optimize the magnitude and uniformity of response, the focusing-electrode potential should be adjusted to that value which provides maximum anode current. The focusing electrode may be connected to the arm of a potentiometer as shown in **Figures 7** and **8**.

A typical focusing-electrode characteristic for the 6810A is shown in **Figure 3**.

The accelerating electrode, when operated at a suitable potential with respect to dynode No.13, serves to minimize the effect of space charge in the region of dynode No.12. Provision should be made to adjust the accelerating-electrode voltage over a range extending from the value at which dynode No.13 operates to that at which the anode operates.

The adjustment may be accomplished by means of a high-resistance potentiometer connected between the voltage-divider tap for dynode No.13 and the anode end of the voltage divider. Since the accelerating electrode draws at most only negligible current, the potentiometer can have sufficiently high resistance so that it will not substantially affect the voltage distribution at the taps of the shunted section of the divider. Within the specified adjustment range, it will be found that the accelerating-electrode voltage may be adjusted to obtain either maximum gain or maximum peak output current. In general, the adjustment to apply the highest voltage to the accelerating electrode will permit the highest peak current with some sacrifice in gain.

Typical Time-Resolution Characteristics

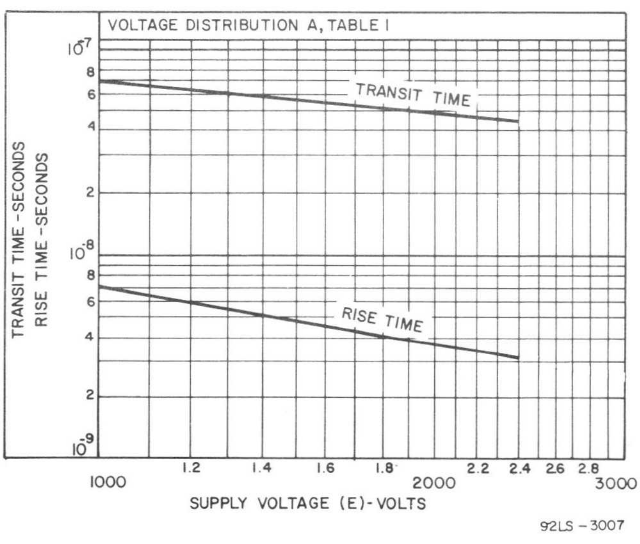


Figure 2

Typical Focusing Electrode Characteristic

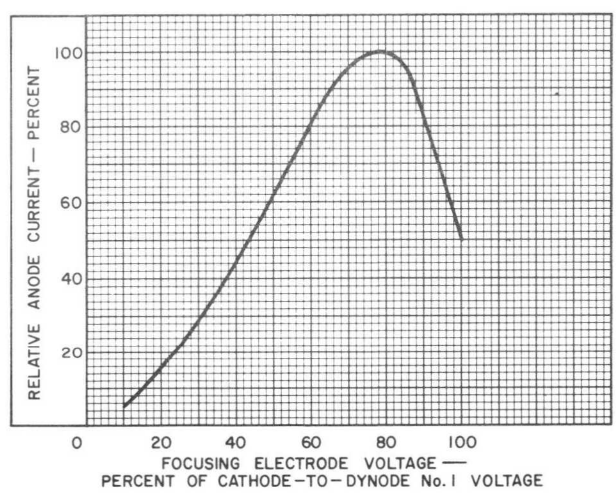


Figure 3

In applications where it is desired to keep the statistical fluctuations to a minimum, e.g., as in nuclear radiation spectroscopy, the potential between cathode and dynode No. 1 may be increased to the rated maximum value of 500 volts.

Typical voltage-divider arrangements for use with the 6810A are shown in **Figures 7** and **8**. Recommended resistance values for the voltage divider range from 10 kilohms per stage to 10 megohms per stage. The choice of resistance values for any voltage-divider network is usually a compromise. If low values of resistance per stage are utilized, the power drawn from the regulated power supply and the required power rating of the resistors increase. Phototube noise may also increase due to heating if the divider network is mounted near the photocathode. The use of high resistance values per stage may cause deviation from linearity if the voltage-divider current is not maintained at a value of at least 10 times that of the maximum value of average anode current, and may limit anode-current response to pulsed light. The latter effect may be reduced by connecting capacitors between the tube socket terminals for dynodes No. 11 and No. 12, dynodes No. 12 and No. 13, dynodes No. 13 and No. 14, and between dynode No. 14 and anode return.

Sensitivity and Current Amplification Characteristics

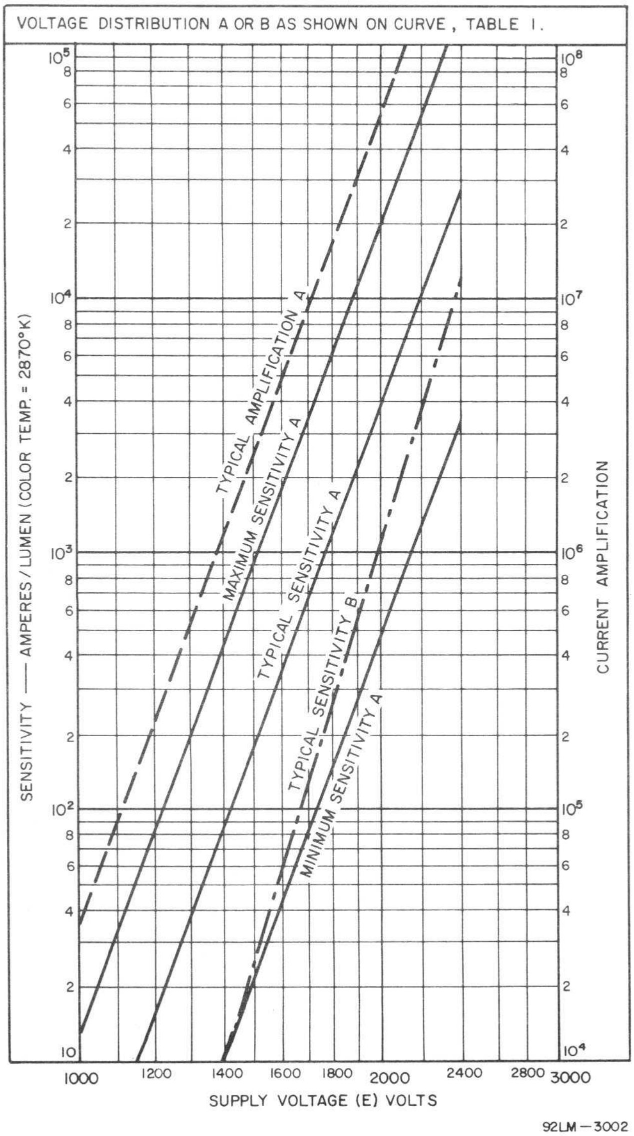


Figure 4

Typical EADCI and Anode Dark Current Characteristics

LUMINOUS SENSITIVITY IS VARIED BY ADJUSTMENT OF THE SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	5.4% OF E MULTIPLIED BY
CATHODE AND FOCUSING ELECTRODE	1.6
CATHODE AND DYNODE No. 1 (DY1)	2
DY1 & DY2	1
DY2 & DY3	1
DY3 & DY4	1
DY4 & DY5	1
DY5 & DY6	1
DY6 & DY7	1
DY7 & DY8	1
DY8 & DY9	1
DY9 & DY10	1
DY10 & DY11	1
DY11 & DY12	1.25
DY12 & DY13	1.5
DY13 & DY14	1.75
DY14 & ANODE	2
ANODE & CATHODE	18.5

GRID–No. 2 VOLTS ADJUSTED TO GIVE MAXIMUM ANODE CURRENT.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870°K.
TUBE TEMPERATURE = 22°C

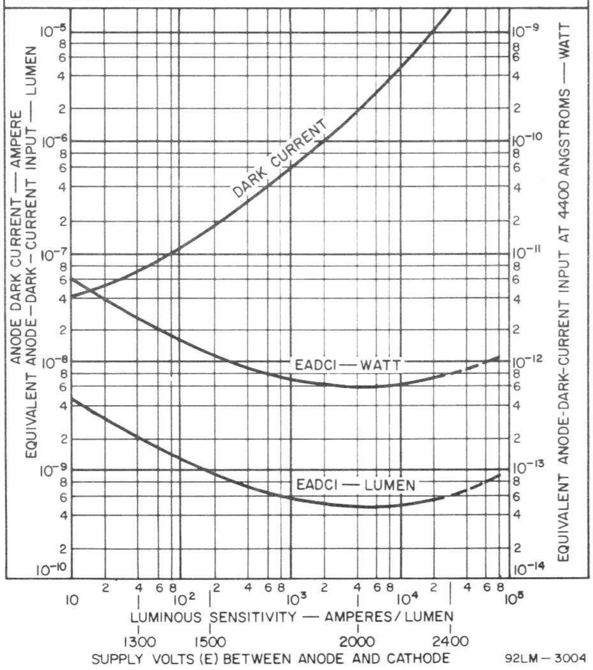


Figure 5

Leads to all capacitors should be as short as possible to minimize inductance effects.

The capacitor values across the dynode stages will depend upon the shape and the amplitude of the anode-current pulse, and the time duration of the pulse, or train of pulses. When the output pulse is assumed to be rectangular in shape, the following formula applies.

$$C = 100 \frac{i \cdot t}{V}$$

where C is in farads

i is the amplitude of anode current in amperes

V is the voltage across the capacitor in volts

and t is the time duration of the pulse in seconds

This formula applies for the anode-to-final dynode capacitor. The factor 100 is used to limit the voltage change across the capacitor to 1% maximum during a pulse. Capacitor values for preceding stages should take into account the smaller values of dynode currents in these stages. Conservatively, a factor of approximately 2 per stage is used. Capacitors are not required across those dynode stages where the dynode current is less than 1/10 of the current through the voltage-divider network.

For other shaped pulses or for a train of pulses, the total charge q should be substituted for (i·t) and the following formula applies:

$$C = 100 \frac{q}{V}$$

where $q = \int i(t)\, dt$ coulombs

In addition to nonlinearity and pulse-limiting effects, the use of resistance values exceeding 10 megohms per stage make the 6810A more susceptible to leakage effects between terminals with possible resulting deviation in interstage voltage leading to a loss of current amplification.

Voltage Distribution B is recommended where high dynode-No. 1 gain is important, such as low light level and scintillation counting applications. Voltage Distribution B maintains the cathode to dynode-No. 1 voltage constant at 360 volts; it is especially useful when the supply voltage is adjusted over a wide range to achieve large changes in anode sensitivity. A suggested circuit using voltage distribution B is shown in **Figure 8**.

The high voltages at which the 6810A is operated are very dangerous. Care should be taken in the design of apparatus to prevent the operator from coming in contact with these high voltages. Precautions should include the enclosure of high-potential terminals and the use of interlock switches to break the primary circuit of the high-voltage power supply when access to the apparatus is required.

In the use of the 6810A as with other tubes requiring high voltages, it should always be remembered that these high voltages may appear at points in the circuit which are normally at low potential, because of defective circuit parts or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned off and both terminals of any capacitors grounded.

Typical Anode Characteristics

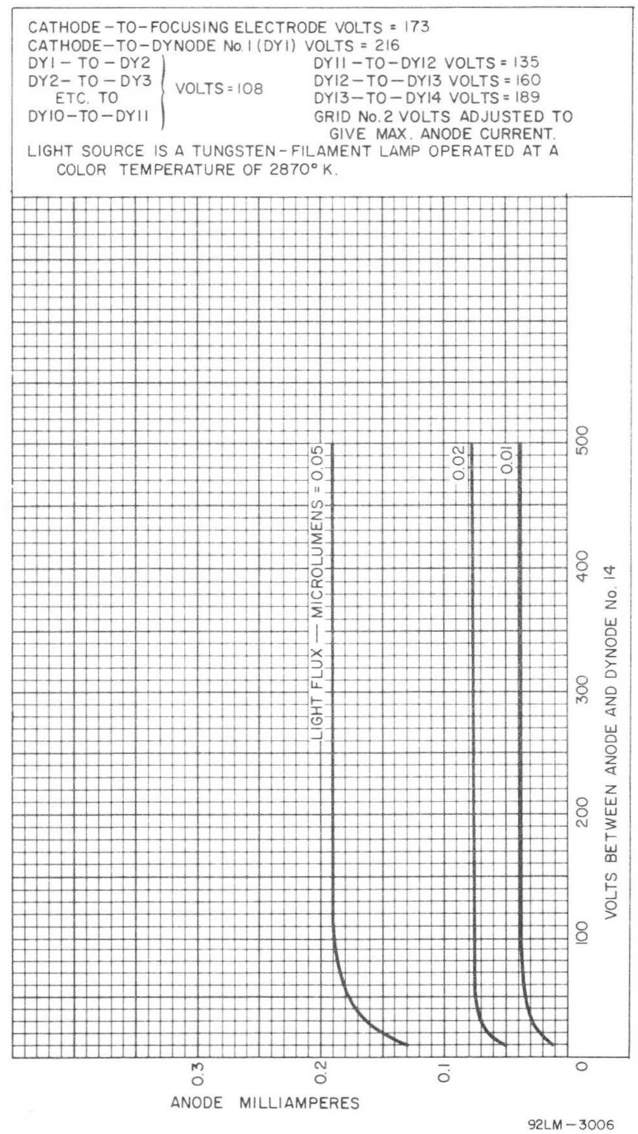
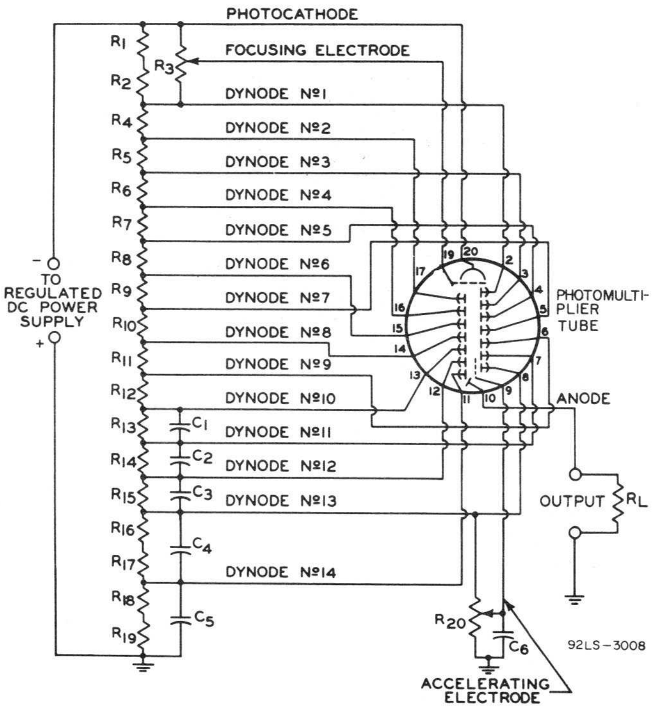


Figure 6

Typical Voltage-Divider Arrangement



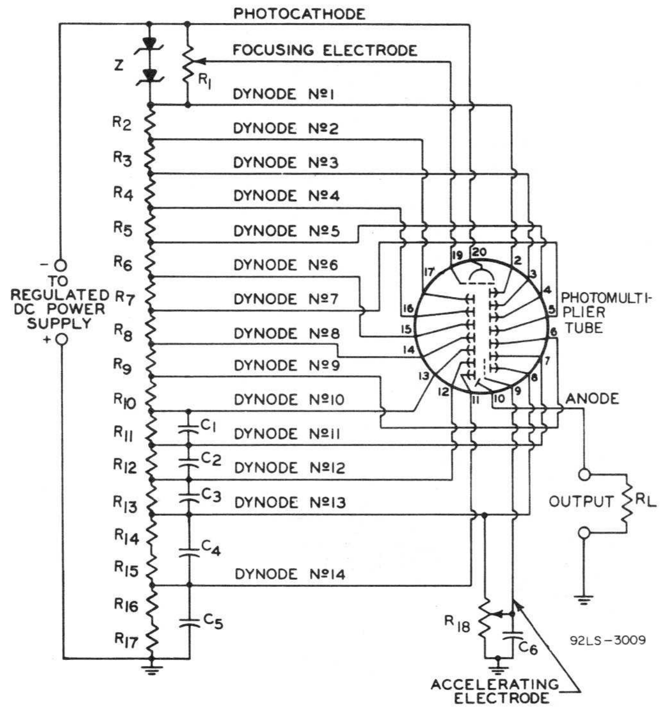
C_1: 25 pF, 20%, 600 volts (dc working), ceramic disc
C_2: 50 pF, 20%, 600 volts (dc working), ceramic disc
C_3: 100 pF, 20%, 600 volts (dc working), ceramic disc
C_4: 250 pF, 20%, 600 volts (dc working), ceramic disc
C_5: 500 pF, 20%, 600 volts (dc working), ceramic disc
C_6: 100 pF, 20%, 1000 volts (dc working), ceramic disc
R_1: 24000 ohms, 5%, 1 watt
R_2: 22000 ohms, 5%, 1 watt
R_3: 1 megohm, 20%, 2 watts, adjustable
R_4 through R_{13}: 22000 ohms, 5%, 1 watt
R_{14}: 27000 ohms, 5%, 2 watts
R_{15}: 33000 ohms, 5%, 2 watts
R_{16}: 22000 ohms, 5%, 2 watts
R_{17}: 18000 ohms, 5%, 2 watts
R_{18}: 22000 ohms, 5%, 2 watts
R_{19}: 22000 ohms, 5%, 2 watts
R_{20}: 10 megohms, 2 watts, adjustable
R_L: Value will depend on magnitude of peak pulse voltage desired. For a peak pulse amplitude of 100 volts, the value is approximately 300 ohms.

Note 1: Adjustable between approximately 800 and 2400 volts dc.

Note 2: Component values are dependent upon nature of application and output signal desired. See discussion on Typical Voltage Dividers — Pages 5 and 6.

Figure 7

Typical Voltage-Divider Arrangement for Constant Voltage Between Cathode and Dynode No. 1



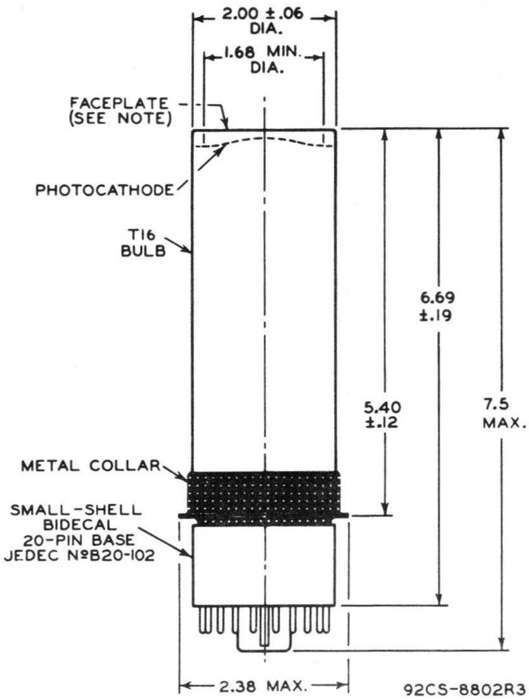
C_1: 25 pF, 20%, 600 volts (dc working), ceramic disc
C_2: 50 pF, 20%, 600 volts (dc working), ceramic disc
C_3: 100 pF, 20%, 600 volts (dc working), ceramic disc
C_4: 250 pF, 20%, 600 volts (dc working), ceramic disc
C_5: 500 pF, 20%, 600 volts (dc working), ceramic disc
C_6: 100 pF, 20%, 1000 volts (dc working), ceramic disc
R_1: 5 megohms, 20%, 1/2 watt, adjustable
R_2 through R_{11}: 22000 ohms, 5%, 1 watt
R_{12}: 27000 ohms, 5%, 2 watts
R_{13}: 33000 ohms, 5%, 2 watts
R_{14}: 22000 ohms, 5%, 2 watts
R_{15}: 18000 ohms, 5%, 2 watts
R_{16}: 22000 ohms, 5%, 2 watts
R_{17}: 22000 ohms, 5%, 2 watts
R_{18}: 10 megohms, 2 watts, adjustable
R_L: Value will depend on magnitude of peak pulse voltage desired. For a peak pulse amplitude of 100 volts, the value is approximately 300 ohms.
Z: (2) - 180 V, 2 W zener diodes, or equivalent

Note 1: Adjustable between approximately 800 and 2400 volts dc.

Note 2: Component values are dependent upon nature of application and output signal desired. See discussion on Typical Voltage Dividers — Pages 5 and 6.

Figure 8

Dimensional Outline



℄ of bulb will not deviate more than 2° in any direction from the perpendicular erected at the center of bottom of the base.

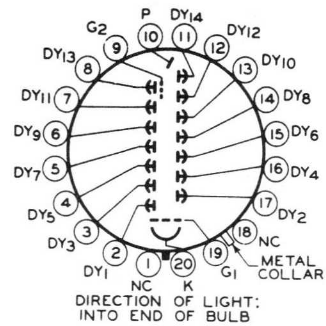
Note: Deviation from flatness of external surface of faceplate will not exceed 0.005" from peak to valley.

Dimensions are in inches unless otherwise stated. Dimensions tabulated below are in millimeters and are derived from the basic inch dimensions (1 inch = 25.4 mm).

Inch Dimension Equivalents in Millimeters

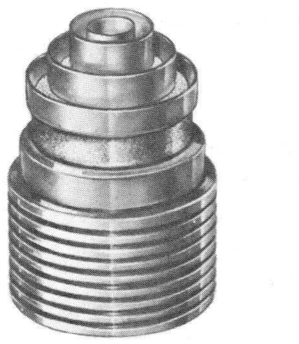
Inch	mm	Inch	mm	Inch	mm
0.06	1.5	1.68	42.6	5.40	137.1
0.12	3.0	2.00	50.8	6.69	169.9
0.19	4.8	2.38	60.4	7.5	190.5

Basing Diagram
Bottom View



20 D

Pin 1: No Connection
Pin 2: Dynode No.1
Pin 3: Dynode No.3
Pin 4: Dynode No.5
Pin 5: Dynode No.7
Pin 6: Dynode No.9
Pin 7: Dynode No.11
Pin 8: Dynode No.13
Pin 9: Grid No.2 (Accelerating Electrode)
Pin 10: Anode
Pin 11: Dynode No.14
Pin 12: Dynode No.12
Pin 13: Dynode No.10
Pin 14: Dynode No.8
Pin 15: Dynode No.6
Pin 16: Dynode No.4
Pin 17: Dynode No.2
Pin 18: No Connection
Pin 19: Grid No.1 (Focusing Electrode)
Pin 20: Photocathode
Metal Collar: No Connection
Note – If used, connect only to photocathode.



CERMOLOX

Oxide-Coated Cathode

Forced-Air Cooled

80 Watts CW Power Output at 400 MHz

40 Watts CW Power Output at 1215 MHz

RCA-6816

BEAM POWER TUBE

RCA-6816 is a very small, forced-air cooled uhf beam power tube designed for use in compact aircraft, mobile and stationary equipment. It is rated as an af power amplifier and modulator and to frequencies up to 1215 MHz as a linear rf power amplifier in single-side-band suppressed-carrier service, as a plate-modulated rf power amplifier in Class C telephony service, as an rf power amplifier and oscillator in Class C telegraphy service, and as an rf power amplifier in Class C FM telephony service.

The 6816 and variants of its basic design may also be useful in applications such as frequency multipliers, linear rf power amplifiers (AM or television), pulse modulators, pulsed-rf amplifiers, regulators, or other special services. Variations in cooling structure or parameters are also possible. For information on variants, contact your RCA field representative.

The 6816 features the Cermolox construction, a unipotential cathode of the oxide-coated type, and an integral stacked-disc-type finned radiator. Details of these features are described in the **Application Guide for RCA Power Tubes, 1CE-300.**

INDEX

*This bulletin is to be used in conjunction with the publication, Application Guide for RCA Power Tubes, 1CE-300. For a copy, write RCA, Commercial Engineering, Harrison, N.J.

▲Erie Technological Products, Inc., 2206 West 15th Street, Erie, Pennsylvania

■E.F. Johnson Co., 299 10th Ave., S.W., Waseca, Minn.

GENERAL DATA

Electrical:

Heater for Oxide-Coated Unipotential Cathode:		
Voltage (ac or dc)	6.3 typical / 6.9 max.	volts
Current at 6.3 volts	2.1	A
Minimum heating time	1	minute

See further information on the heater in **Application Guide for RCA Power Tubes, 1CE-300;** *Section V.A.3,* **Filament or Heater.**

Mu-Factor, Grid No.2 to Grid No.1	18	
Direct Interelectrode Capacitances[a]:		
Grid No.1 to plate	0.065 max.	pF
Grid No.1 to cathode & heater	13	pF
Plate to cathode & heater	.013 max.	pF
Grid No.1 to grid No.2	18	pF
Grid No.2 to plate	4.8	pF
Grid No.2 to cathode & heater	0.45 max.	pF

Mechanical:

Operating Position	Any
Overall Length	1.93" max.
Greatest Diameter	1.265" max.
Terminal Connections	See *Dimensional Outline*

For operation up to 400 MHz

Socket, including Grid-No.2 Bypass Capacitor	Erie▲ 2948-000, E.F. Johnson■ DN124-152-1, Jettron● 89-001, or equivalent
Grid-No.2 Bypass Capacitor	Erie▲ 2926-000, 2929-001, or equivalent

For operation at high frequencies

See Preferred Mounting Arrangement	Page 4
Radiator	Integral part of tube
Weight (Approx.)	2 oz.

Thermal:

Terminal Temperature (Plate, grid No.2, grid No.1, cathode, and heater)	250 max. °C
Plate-Core Temperature	250 max. °C

See Dimensional Outline for temperature-measurement points

●Jettron Products, Inc., 56 Rt. 10, Hanover, N.J.

RADIO CORPORATION OF AMERICA
Electronic Components and Devices Harrison, N. J.

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Supersedes 6816 8/60 6816 8/66

AF POWER AMPLIFIER & MODULATOR—Class AB_1[b]

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC Plate Voltage	1000 max.	volts
DC Grid-No.2 Voltage	300 max.	volts
Max.-Signal DC Plate Current	180 max.	mA
Max.-Signal Plate Input	180 max.	watts
Max.-Signal Grid-No.2 Input	4.5 max.	watts
Plate Dissipation	115 max.	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance under Any Condition:

With fixed bias	30000 max. ohms
With cathode bias	Not recommended

Typical CCS Operation:

Values are for 2 tubes

DC Plate Voltage	650	850	volts
DC Grid-No.2 Voltage	300	300	volts
DC Grid-No.1 Voltage: From fixed-bias source	−15	−15	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	30	30	volts
Zero-Signal DC Plate Current	80	80	mA
Max.-Signal DC Plate Current	200	200	mA
Zero-Signal DC Grid-No.2 Current	0	0	mA
Max.-Signal DC Grid-No.2 Current	20	20	mA
Effective Load Resistance (Plate to plate)	4330	7000	ohms
Max.-Signal Driving Power (Approx.)	0	0	watts
Max.-Signal Power Output (Approx.)	50	80	watts

AF POWER AMPLIFIER & MODULATOR—Class AB_2[b]

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC Plate Voltage	1000 max.	volts
DC Grid-No.2 Voltage	300 max.	volts
Max.-Signal DC Plate Current	180 max.	mA
Max.-Signal DC Grid-No.1 Current	30 max.	mA
Max.-Signal Plate Input	180 max.	watts
Max.-Signal Grid-No.2 Input	4.5 max.	watts
Plate Dissipation	115 max.	watts

Typical CCS Operation:

Values are for 2 tubes

DC Plate Voltage	650	850	volts
DC Grid-No.2 Voltage	300	300	volts
DC Grid-No.1 Voltage: From fixed-bias source	−15	−15	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	46	46	volts
Zero-Signal DC Plate Current	80	80	mA
Max.-Signal DC Plate Current	355	355	mA
Zero-Signal DC Grid-No.2 Current	0	0	mA
Max.-Signal DC Grid-No.2 Current	25	25	mA
Max.-Signal DC Grid-No.1 Current	15	15	mA
Effective Load Resistance (Plate to plate)	2450	3960	ohms
Max.-Signal Driving Power (Approx.)	0.3	0.3	watt
Max.-Signal Power Output (Approx.)	85	140	watts

PLATE-MODULATED RF POWER AMPLIFIER—Class C Telephony[b]

Carrier conditions per tube for use with a max. modulation factor of 1.0

Maximum CCS Ratings, *Absolute-Maximum Values*

	Up to 1215 MHz:	
DC Plate Voltage	800 max.	volts
DC Grid-No.2 Voltage	300 max.	volts
DC Grid-No.1 Voltage	−100 max.	volts
DC Plate Current	150 max.	mA
DC Grid-No.1 Current	30 max.	mA
Plate Input	120 max.	watts
Grid-No.2 Input	3 max.	watts
Plate Dissipation	75 max.	watts

Typical CCS Operation:

	At 400 MHz:		
DC Plate Voltage	400	700	volts
DC Grid-No.2 Voltage	200	250	volts
DC Grid-No.1 Voltage	−20	−50	volts
DC Plate Current	100	130	mA
DC Grid-No.2 Current	5	10	mA
DC Grid-No.1 Current	5	10	mA
Driver Power Output (Approx.)	2	3	watts
Useful Power Output (Approx.)	16	45	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance under Any Condition . . . 30000 max. ohms

RF POWER AMPLIFIER & OSCILLATOR—Class C Telegraphy[b] and RF POWER AMPLIFIER—Class C FM Telephony

Maximum CCS Ratings, *Absolute-Maximum Values:*

	Up to 1215 MHz:	
DC Plate Voltage	1000 max.	volts
DC Grid-No.2 Voltage	300 max.	volts
DC Grid-No.1 Voltage	−100 max.	volts
DC Plate Current	180 max.	mA
DC Grid-No.1 Current	30[f] max.	mA
Plate Input	180 max.	watts
Grid-No.2 Input	4.5 max.	watts
Plate Dissipation	115 max.	watts

Typical CCS Operation:

	At 400 MHz		*At 1215 MHz*	
DC Plate Voltage	400	900	900	volts
DC Grid-No.2 Voltage	200	300	300	volts
DC Grid-No.1 Voltage	−35	−30	−22	volts
DC Plate Current	150	170	170	mA
DC Grid-No.2 Current	5	1	1	mA
DC Grid-No.1 Current	3	10	4	mA
Driver Power Output (Approx.)	3	3	5	watts
Useful Power Output (Approx.)	23	80	40	watts

Maximum Circuit Values:

Grid-No.1- Circuit Resistance under Any Condition . . . 3000 max. ohms

LINEAR RF POWER AMPLIFIER, Class AB1[b]
Single-Sideband Suppressed-Carrier Service

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2

Maximum CCS Ratings, *Absolute-Maximum Values:*

	Up to 1215 MHz	
DC Plate Voltage	1000	max. volts
DC Grid-No.2 Voltage	300	max. volts
DC Grid-No.1 Voltage	−100	max. volts
DC Plate Current at Peak of Envelope	250[c]	max. mA
DC Grid-No.1 Current	30	max. mA
Plate Input	180	max. watts
Grid-No.2 Input	4.5	max. watts
Plate Dissipation	115	max. watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Condition:		
With fixed bias	25000	max. ohms
With fixed bias (In Class AB1 operation)	100000	max. ohms
With cathode bias	Not recommended	
Grid-No.2 Circuit Impedance	See Note **d**	
Plate Circuit Impedance	See Note **e**	

Typical CCS Operation with "Two-Tone" Modulation:

	At 30 MHz		
DC Plate Voltage	650	850	volts
DC Grid-No.2 Voltage	300	300	volts
DC Grid-No.1 Voltage	−18.5	−18.5	volts
Zero-Signal DC Plate Current	40	40	mA
Effective RF Load Resistance	2200	3500	ohms
DC Plate Current at Peak of Envelope	100	100	mA
Average DC Plate Current	75	75	mA
DC Grid-No.2 Current at Peak of Envelope	8.2	4.2	mA
Average DC Grid-No.2 Current	3.6	1.7	mA
Peak-Envelope Driver Power Output (Approx.)	0.5	0.5	watt
Output-Circuit Efficiency (Approx.)	90	90	%
Distortion Products Level:			
Third Order	35	30	dB
Fifth Order	40	36	dB
Useful Power Output (Approx.):			
Average	12.5	20	watts
Peak envelope	25	40	watts

FOOTNOTES for *General Data and Ratings*

[a]Measured with special shield adapter.

[b]See Section V.C. of 1CE-300.

[c]The maximum rating for a signal having a minimum peak-to-average power ratio less than 2, such as is obtained in "Single-Tone" operation, is 180 mA. During short periods of circuit adjustment under "Single-Tone" conditions, the average plate current may be as high as 250 mA.

[d]See Section V.B. 2 of 1CE-300.

[e]See Section V.B.1 of 1CE-300.

[f]In applications where the frequency is less than 80 MHz and the bias is less than −50 volts, the maximum value is 40 mA.

CHARACTERISTICS RANGE VALUES

	Note	*Min.*	*Max.*	
1. Heater Current	1	1.84	2.26	A
2. Direct Interelectrode Capacitances:				
Grid No.1 to plate	2	–	0.065	pF
Grid No.1 to cathode & heater	2	11.0	15.0	pF
Plate to cathode & heater	2	–	0.013	pF
Grid No.1 to grid No.2	2	15.0	20.0	pF
Grid No.2 to plate	2	4.2	5.2	pF
Grid No.2 to cathode & heater	2	0.20	0.45	pF
3. Grid-No.1 Voltage	1,3	−6	−15	volts
4. Grid-No.1 Cutoff Voltage	1,4	–	−48	volts
5. Grid-No.1 Current	1,5	6	–	mA
6. Reverse Grid-No.1 Current	1,3	–	8	µA
7. Grid-No.2 Current	1,3	−8	+2.0	mA
8. Peak Emission	1,6	–	300	peak volts
9. Interelectrode Leakage Resistance	7	1.0	–	megohm
10. Useful Power Output	8	80	–	watts

NOTE 1: With 6.3 volts ac or dc on heater.

NOTE 2: Measured with special shield adapter.

NOTE 3: With dc plate voltage of 1000 volts, dc grid-No.2 voltage of 300 volts, and dc grid-No.1 voltage adjusted to give a dc plate current of 115 mA.

NOTE 4: With dc plate voltage of 1000 volts, dc grid-No.2 voltage of 300 volts, and dc grid-No.1 voltage adjusted to give a dc plate current of 1 mA.

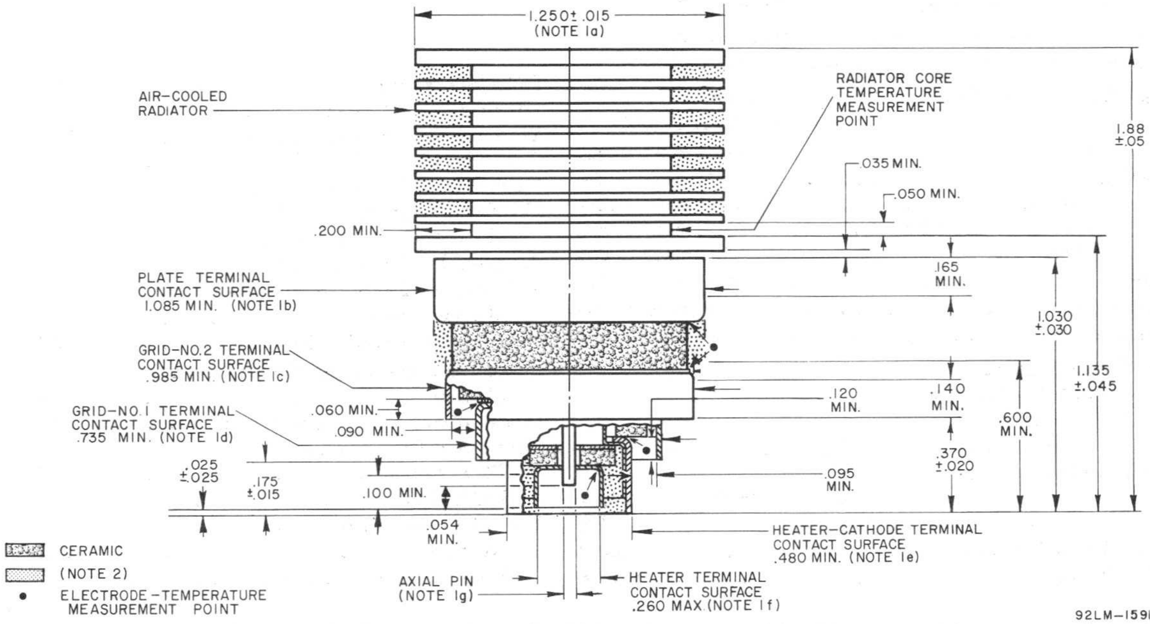
NOTE 5: With plate and grid-No.2 floating and dc grid-No.1 voltage of +2 volts.

NOTE 6: With grid No.1, grid No.2, and plate tied together; and pulse voltage source connected between plate and cathode. Pulse duration is 2 microseconds, pulse repetition frequency is 60 pps, and duty factor is 0.00012. The voltage-pulse amplitude is adjusted until a peak cathode current of 10 amperes is obtained. After 1 minute at this value, the voltage-pulse amplitude will not exceed 300 volts (peak).

NOTE 7: With tube at 20° to 30° C for at least 30 minutes without any voltages applied to the tube. The minimum resistance between any two adjacent electrodes as measured with a 200-volt Megger-type ohmmeter having an internal impedance of 1.0 megohm, will be 1.0 megohm.

NOTE 8: In a single-tube, grid-driven coaxial-cavity class C amplifier circuit at 400 MHz and for conditions with 5.7 volts ac or dc on heater, dc plate voltage of 1000 volts, dc grid-No.2 voltage of 300 volts, grid-No.1 resistor adjustable between zero and 10000 ohms, dc plate current of 180 mA maximum, dc grid-No.1 current of 30 mA maximum and driver power output of 3 watts.

DIMENSIONAL OUTLINE



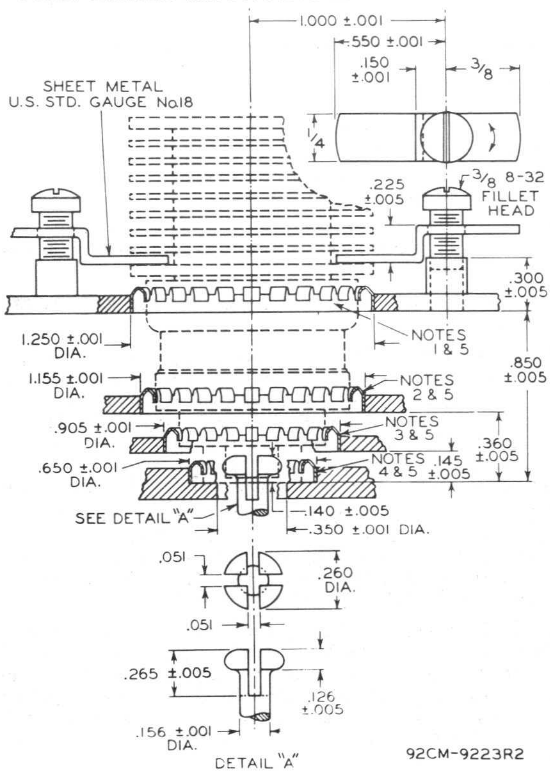
DIMENSIONS IN INCHES

NOTE 1: The following diametrical space requirements accommodate the concentricity of the cylindrical surfaces of the radiator fins, axial pin, and each electrode terminal:

a. Radiator Band – 1.316"
b. Plate Terminal – 1.119"
c. Grid-No.2 Terminal – 1.019"
d. Grid-No.1 Terminal – 0.764"
e. Heater-Cathode Terminal – 0.519"
f. Heater Terminal – 0.240"
g. Axial Pin – 0.071"

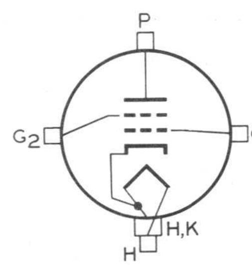
NOTE 2: Keep all stippled regions clear. Do not allow contacts or circuit components to protrude into these annular volumes.

PREFERRED MOUNTING ARRANGEMENT



DIMENSIONS IN INCHES

TERMINAL DIAGRAM



See Dimensional Outline for Terminal Connections

NOTE 1: Contact ring No.97-252 or finger stock No.97-380.

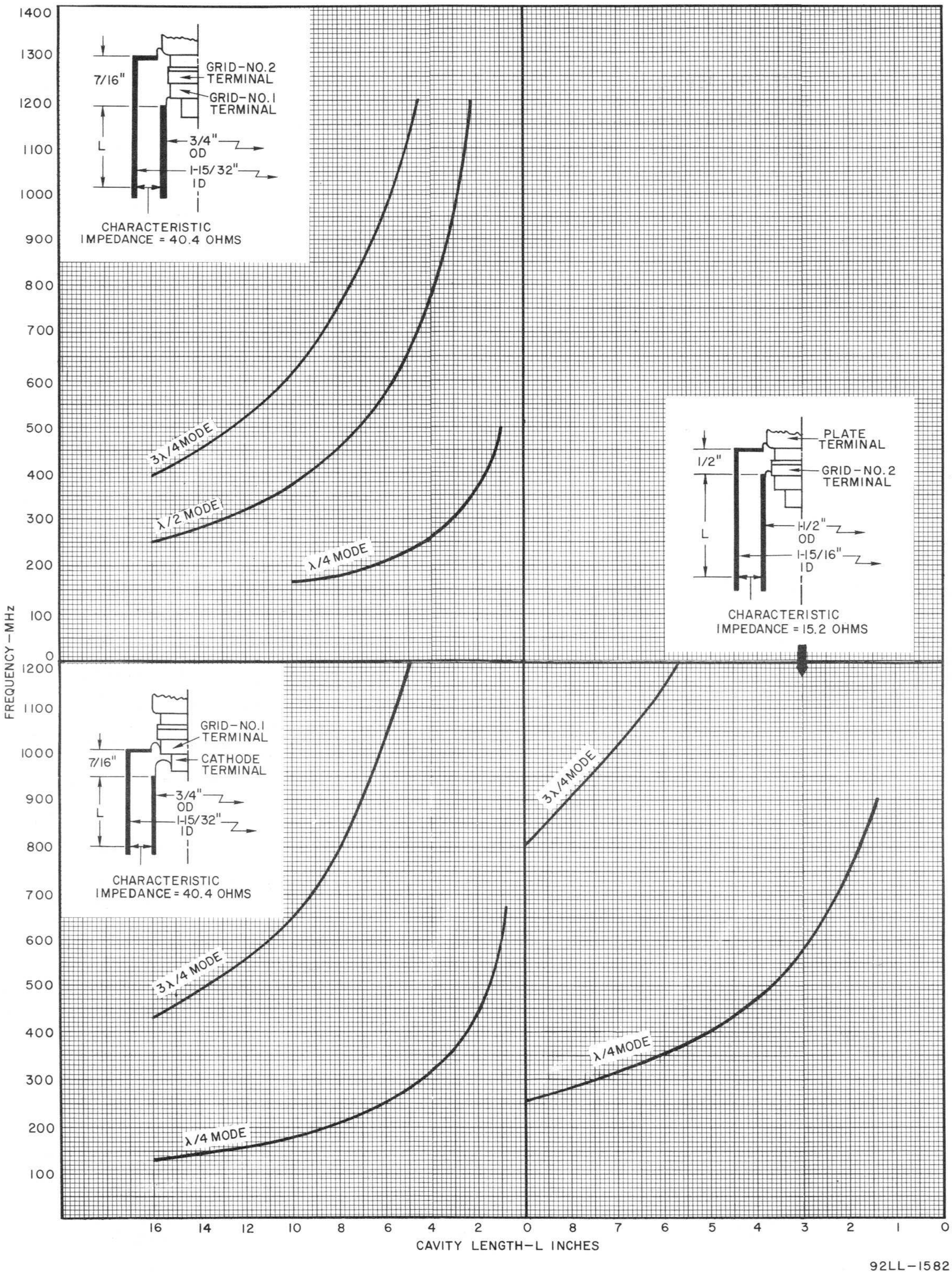
NOTE 2: Contact ring No.97-253 or finger stock No.97-380.

NOTE 3: Contact ring No.97-254 or finger stock No.97-380.

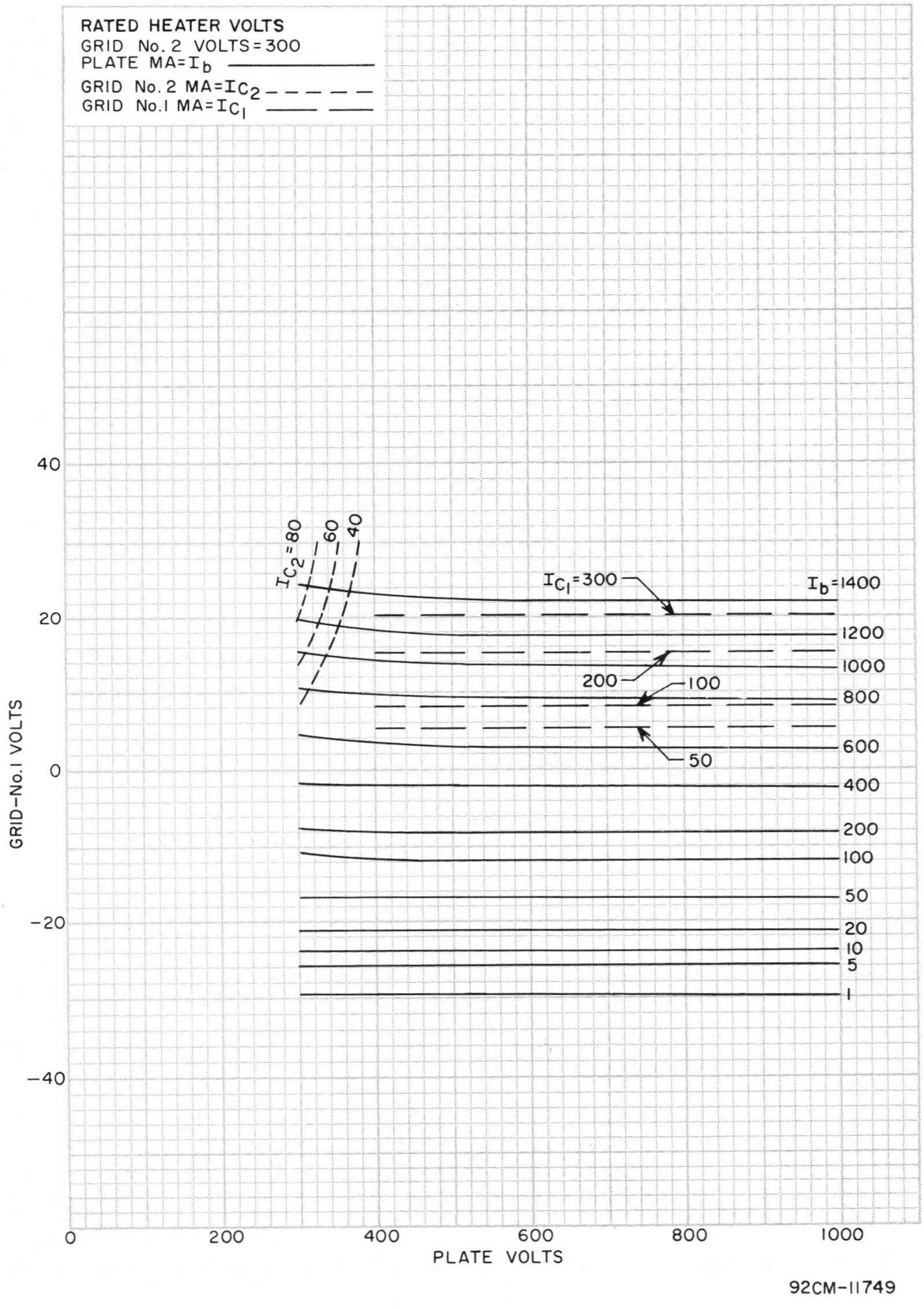
NOTE 4: Contact ring No.97-255 or finger stock No.97-380.

NOTE 5: The specified contact ring of preformed finger stock and finger stock No.97-380 provide adequate electrical contact, but the finger stock No.97-380 is less susceptible to breakage than the specified contact ring. Both types are made by Instruments Specialties Co., Little Falls, N.J.

TUNING CHARACTERISTICS

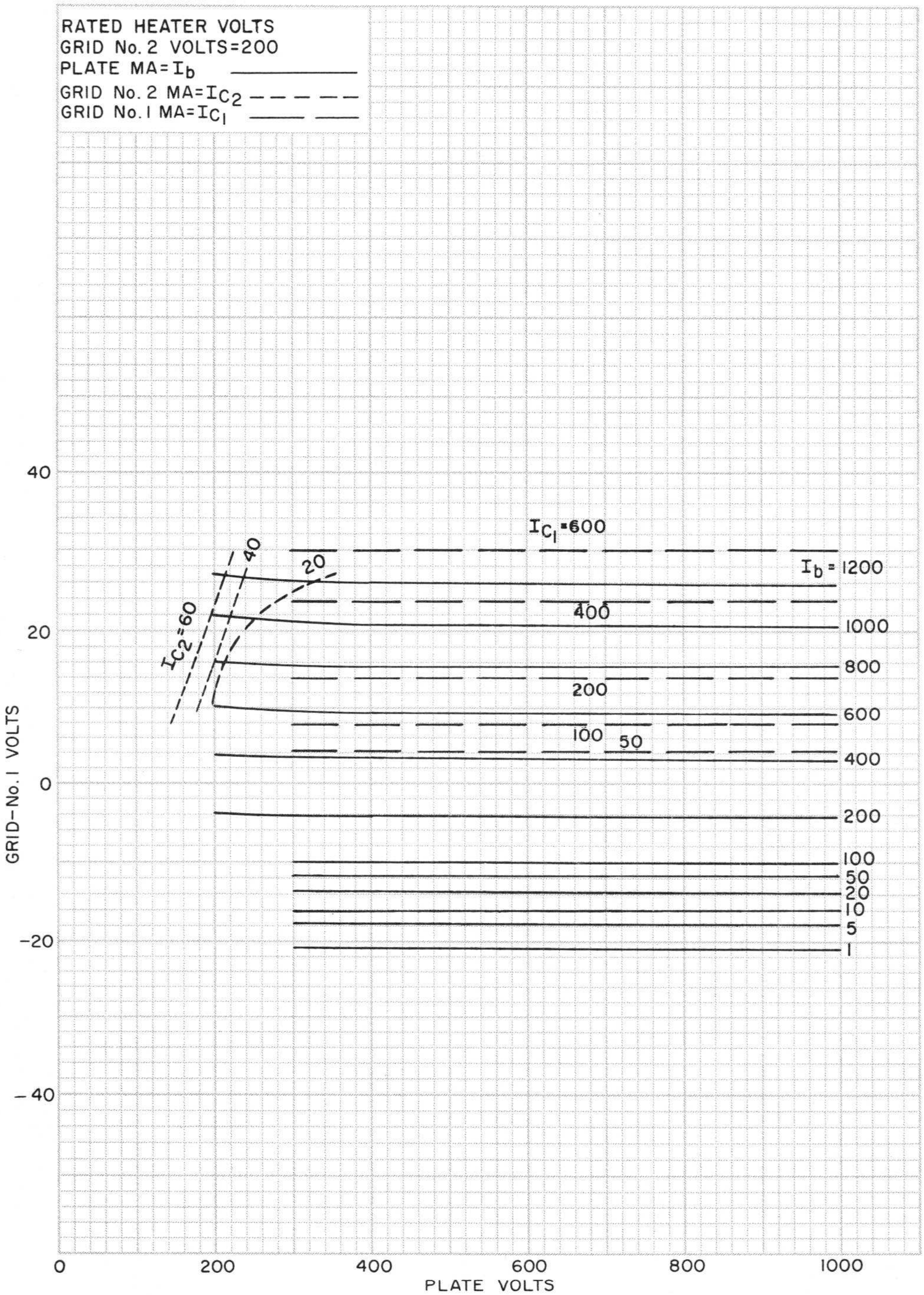


TYPICAL CONSTANT-CURRENT CHARACTERISTICS
With Grid-No.2 Volts = 300



TYPICAL CONSTANT-CURRENT CHARACTERISTICS

With Grid-No.2 Volts = 200



92CM-11745

FORCED-AIR COOLING

Air Flow:

Through radiator — Adequate air flow to limit the radiator core temperature to 250° C should be delivered by a blower across the radiator before and during the application of plate, grid-No.2, and grid-No.1 voltages. Typical values of air flow directed across the radiator versus plate dissipation are shown in two graphs under *Typical Cooling Requirements*.

To Plate, Grid-No.2, Grid-No.1, Cathode, and Heater Terminals — A sufficient quantity of air should flow across each of these terminals so that their temperature does not exceed the specified maximum value of 250° C.

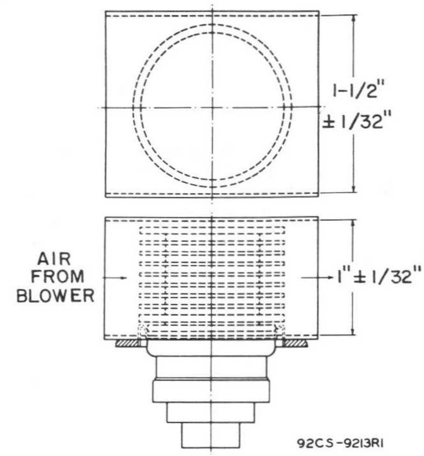
During Standby Operation — Cooling air is not normally required when only heater voltage is applied to the tube.

Plate power, grid-No.2 power, heater power, and air flow may be removed simultaneously.

At sea level cooling requirements with air flow directed across the radiator with cowling as indicated may be met by use of blowers and associated motors manufactured by Rotron Mfg. Co., Inc., Woodstock, N.Y., or equivalent.

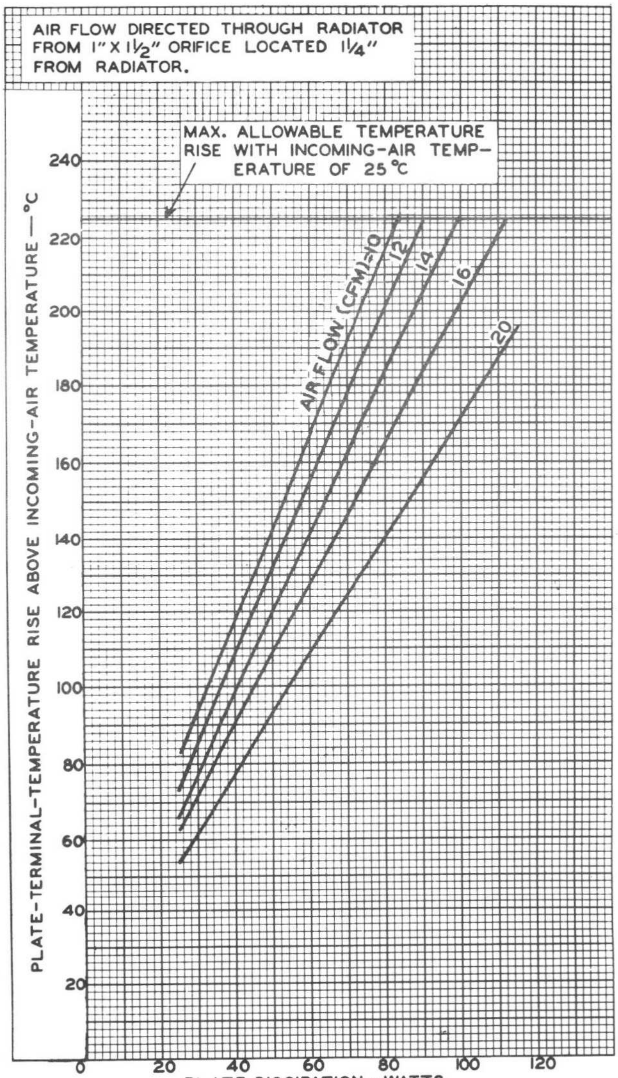
RECOMMENDED COWLING

For Directing Air Flow Through Radiator

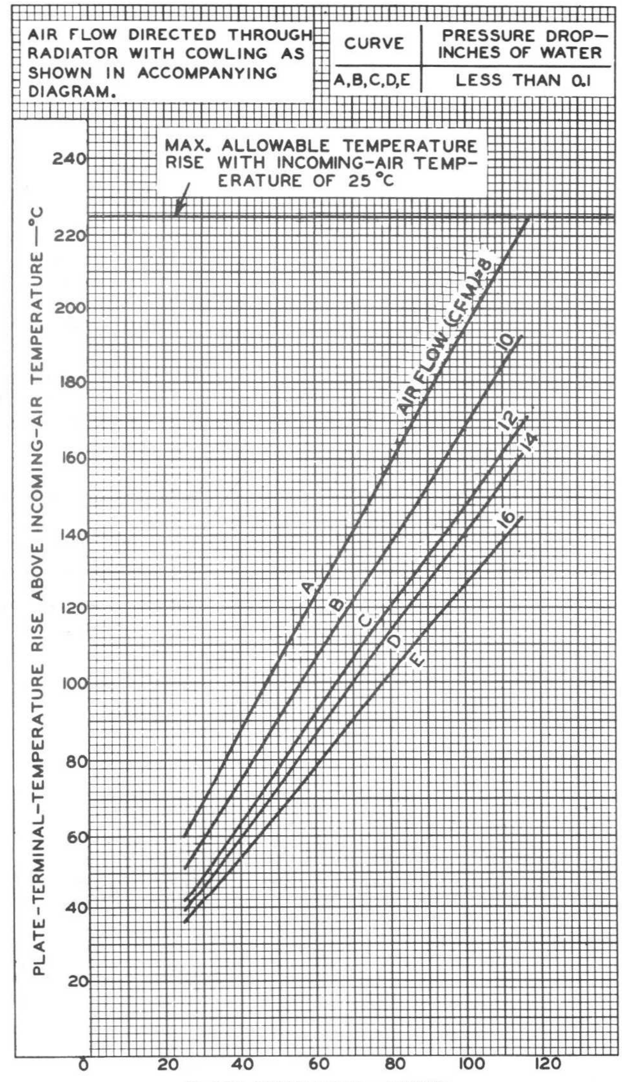


92CS-9213R1

TYPICAL COOLING REQUIREMENTS

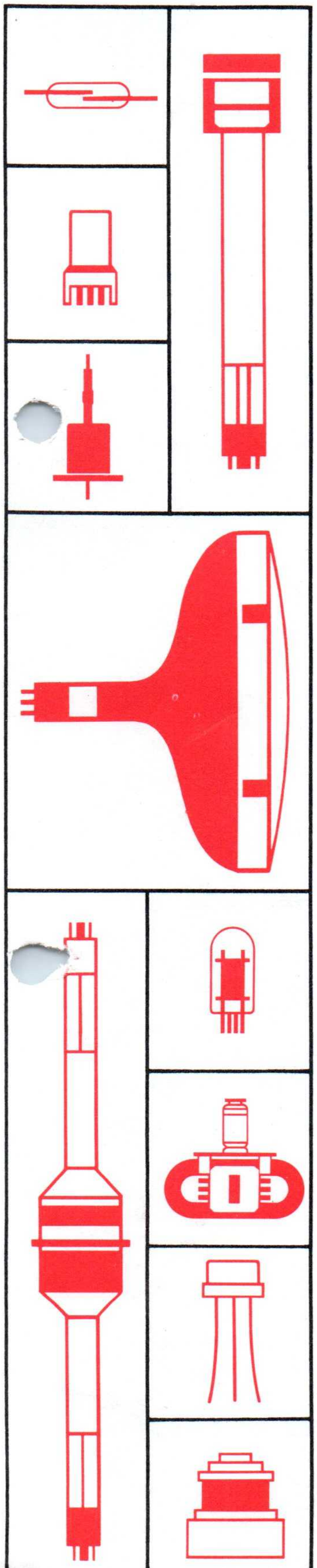


92CM-9220R1



92CM-9219R1

NEW PRODUCT ANNOUNCEMENT



RADIO CORPORATION OF AMERICA

INTERNATIONAL DIVISION / HARRISON, N. J.

LICENSEE SERVICE

NEW BEAM POWER TUBE
RCA-6883B/8032A/8552

85 Watts CW Output (ICAS) at 60 Mc

50 Watts CW Output (ICAS) at 175 Mc

NOW—

A 12 TO 15-VOLT TYPE

to give you all the outstanding features of the recently announced RCA-6146B/8298A

YOU GET—

- **EXTENDED LIFE WHEN REPLACING** 6883, 6883A, or 8032
- **HIGHER POWER OUTPUT IN NEW EQUIPMENT DESIGNS**
  - Higher plate dissipation and plate current ratings
  - Higher temperature operation
  - Higher power output
  - RCA "dark heater"
  - Withstands wide excursions of heater voltage in mobile operation

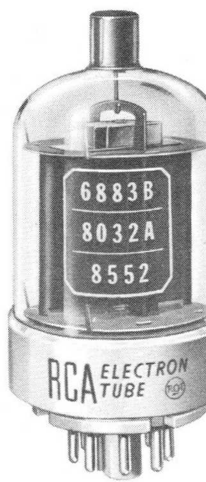
Detailed technical information is given in the attached bulletin.

February 28, 1964

RCA-6883B/8032A/8552

BEAM POWER TUBE

Controlled Zero-Bias Plate Current	**85 Watts CW Output (ICAS) at 60 Mc**	**3-13/16" Max. Length**
Controlled Power Output at Reduced Heater Voltage	**50 Watts CW Output (ICAS) at 175 Mc**	**1-21/32" Max. Diameter**
	RCA "Dark Heater" with 10- to 16-volt Range	**Octal 8-Pin Base**
		Small, Sturdy Structure



RCA-6883B/8032A/8552 is a small, sturdy, beam power tube having high efficiency and high power sensitivity for use in mobile and stationary equipment. It is rated as an af power amplifier and modulator, a linear rf power amplifier, and a Class C rf power amplifier and oscillator

The 6883B features a heater designed to operate over a voltage range of 12 to 15 volts and which will take excursions from 10 to 16 volts in battery operation. The heater design insures dependable performance in mobile equipment under operating conditions during battery charging and discharging. See *Special Performance Data* on page 4 for information covering heater overvoltage and undervoltage operation.

Controlled zero-bias plate current is offered in the 6883B to insure more dependable performance as a Class AB_1 linear rf amplifier for single-sideband suppressed-carrier service. See *Test No.3* of *Characteristics Range Values*.

Also featured in the design of the 6883B is the new RCA "Dark Heater", which functions efficiently at operating temperatures 350° K below those of the heaters in conventional tube types. The dark surface of the new heater radiates heat more efficiently and improves the transfer of heat to the cathode so that optimum cathode temperature may be attained with the heater operating at approximately 1350° K.

The low operating temperature of the "Dark Heater" results in (1) lower internal stresses in the heater wire and smaller thermal change during heater warmup, (2) cooler operation of the heater which minimizes changes in heater shape and reduces the possibility of heater damage and heater shorts, (3) extremely stable heater current characteristics throughout life, and (4) significant reduction in effects of ac heater leakage.

Small in size for its power-output capability, the 6883B has a rugged button-stem construction with short internal leads, a T12 bulb, triple base-pin connections for grid No.3 and cathode (both joined to internal shield inside the tube) to permit effective rf grounding, and an octal base with short metal sleeve having its own base-pin terminal. The sleeve shields the input to the tube and isolates it from the output circuit so completely that no other external shielding is required. Separation of input and output circuits is accomplished by bringing the plate lead out of the bulb to a cap opposite the base.

The 6883B/8032A/8552 is unilaterally interchangeable with the 6883, 6883A, and 8032.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	12.6	volts
Current at 12.6 volts	0.562	amp
Minimum heating time	60	sec

See Special Performance Data on page 4 for heater operation in stationary equipment and in mobile equipment.

Transconductance, for plate volts = 200, grid-No.2 volts = 200, and plate ma. = 100	7000	μmhos
Mu-Factor, Grid No.2 to Grid No.1 for plate volts = 200, grid-No.2 volts = 200, and plate ma. = 100	4.5	
Direct Interelectrode Capacitances (Approx.):[a]		
Grid No.1 to plate	0.24 max.	pf
Grid No.1 to cathode & grid No.3 & internal shield, base sleeve, grid No.2, and heater	13	pf
Plate to cathode & grid No.3 & internal shield, base sleeve, grid No.2, and heater	8.5	pf

Mechanical:

Operating Position	Any
Maximum Overall Length	3-13/16"
Seated Length	3-1/8" ± 1/8"
Maximum Diameter	1-21/32"
Bulb	T12
Cap	Small (JEDEC No.C1-1)
Base	Small-Wafer Octal 8-Pin with Sleeve (JEDEC Group 1, No.B8-150), or Small-Wafer Octal 8-Pin with External Barriers and Sleeve (JEDEC Group 1, No.B8-159)
Bulb Temperature (At hottest point)	260 max. °C
Weight (Approx.)	2.3 oz

AF POWER AMPLIFIER & MODULATOR — Class AB_1

Maximum Ratings, *Absolute-Maximum Values:*

	CCS	*ICAS*	
DC PLATE VOLTAGE	600 max.	750 max.	volts
DC GRID-No.2 VOLTAGE	250 max.	250 max.	volts
MAX.-SIGNAL DC PLATE CURRENT[b]	175 max.	220 max.	ma
MAX.-SIGNAL PLATE INPUT[b]	90 max.	120 max.	watts

	CCS	ICAS	
MAX.-SIGNAL GRID-No.2 INPUT[b]	3 max.	3 max.	watts
PLATE DISSIPATION[b]	27 max.	35 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts

Typical Operation:

Values are for 2 tubes

DC Plate Voltage	600	750	volts
DC Grid-No.2 Voltage[c]	200	200	volts
DC Grid-No.1 Voltage:			
With fixed-bias source	-47	-48	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage[d]	94	96	volts
Zero-Signal DC Plate Current	48	50	ma
Max.-Signal DC Plate Current	250	250	ma
Max.-Signal DC Grid-No.2 Current	14.8	12.6	ma
Effective Load Resistance (Plate to plate)	5600	7200	ohms
Max.-Signal Driving Power (Approx.)	0	0	watts
Max.-Signal Power Output (Approx.)	96	124	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance under Any Condition:[e]

With fixed bias	0.1 max.	megohm
With cathode bias	Not recommended	

AF POWER AMPLIFIER & MODULATOR – Class AB_2

Maximum Ratings, *Absolute-Maximum Values:*

	CCS	ICAS	
DC PLATE VOLTAGE	600 max.	750 max.	volts
DC GRID-No.2 VOLTAGE	250 max.	250 max.	volts
MAX.-SIGNAL DC PLATE CURRENT[b]	175 max.	220 max.	ma
MAX.-SIGNAL PLATE INPUT[b]	90 max.	120 max.	watts
MAX.-SIGNAL GRID-No.2 INPUT[b]	3 max.	3 max.	watts
PLATE DISSIPATION[b]	27 max.	35 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts

Typical CCS Operation:

Values are for 2 tubes

DC Plate Voltage	500	600	volts
DC Grid-No.2 Voltage[c]	200	200	volts
DC Grid-No.1 Voltage:			
From fixed-bias source	-46	-48	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	108	106	volts
Zero-Signal DC Plate Current	50	40	ma
Max.-Signal DC Plate Current	308	270	ma
Max.-Signal DC Grid-No.2 Current	26	27	ma
Max.-Signal DC Grid-No.1 Current	2.7	1.3	ma
Effective Load Resistance (Plate to plate)	3620	5200	ohms
Max.-Signal Driving Power (Approx.)[f]	0.2	0.7	watt
Max.-Signal Power Output (Approx.)	100	110	watts

Typical ICAS Operation:

Values are for 2 tubes

DC Plate Voltage	600	750	volts
DC Grid-No.2 Voltage[c]	200	150	volts
DC Grid-No.1 Voltage:			
From fixed-bias source	-47	-39	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	114	110	volts
Zero-Signal DC Plate Current	50	40	ma
Max.-Signal DC Plate Current	328	294	ma
Max.-Signal DC Grid-No.2 Current	26	28	ma
Max.-Signal DC Grid-No.1 Current	3.4	7.6	ma
Effective Load Resistance (Plate to plate)	4160	6050	ohms
Max.-Signal Driving Power (Approx.)[f]	0.2	0.5	watt
Max.-Signal Power Output (Approx.)	130	148	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance:[g]

With fixed bias	30,000 max.	ohms
With cathode bias	Not recommended	

LINEAR RF POWER AMPLIFIER, Class AB_1
Single-Sideband Suppressed-Carrier Service

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2

Maximum Ratings, *Absolute-Maximum Values:*

	CCS	ICAS	
DC PLATE VOLTAGE	600 max.	750 max.	volts
DC GRID-No.2 VOLTAGE	250 max.	250 max.	volts
DC PLATE CURRENT AT PEAK OF ENVELOPE	175 max.	220 max.	ma
PLATE DISSIPATION	27 max.	35 max.	watts
GRID-No.2 DISSIPATION	3 max.	3 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts

Typical Operation with "Two-Tone Modulation":

At 30 Mc

DC Plate Voltage	600	750	volts
DC Grid-No.2 Voltage[h]	200	200	volts
DC Grid-No.1 Voltage[h]	-47	-48	volts
Zero-Signal DC Plate Current	24	25	ma
Effective RF Load Resistance	2800	3600	ohms
DC Plate Current at Peak of Envelope	125	125	ma
Average DC Plate Current	86	86	ma

	CCS	ICAS	
DC Grid-No.2 Current at Peak of Envelope. . . .	7.4	6.3	ma
Average DC Grid-No.2 Current	5.0	3.9	ma
Distortion Products Level:[i]			
Third order	24	26	db
Fifth order	30	31	db
Useful Power Output (Approx.):			
Average	24.5	30.5	watts
Peak envelope	49	61	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance under Any Condition:
With fixed bias . . . . 30,000 max. ohms

PLATE-MODULATED RF POWER AMPLIFIER – Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0; at frequencies up to 60 Mc

Maximum Ratings, *Absolute-Maximum Values:*

	CCS	ICAS	
DC PLATE VOLTAGE.	480 max.	600 max.	volts
DC GRID-No.2 VOLTAGE. . .	250 max.	250 max.	volts
DC GRID-No.1 VOLTAGE. . .	-150 max.	-150 max.	volts
DC PLATE CURRENT.	145 max.	180 max.	ma
DC GRID-No.1 CURRENT. . .	3.5 max.	4.0 max.	ma
PLATE INPUT	60 max.	85 max.	watts
GRID-No.2 INPUT	2 max.	2 max.	watts
PLATE DISSIPATION	18 max.	23 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode. .	135 max.	135 max.	volts
Heater positive with respect to cathode. .	135 max.	135 max.	volts

Typical Operation:

	CCS	ICAS	
DC Plate Voltage.	475	600	volts
DC Grid-No.2 Voltage[j] . .	165	175	volts
DC Grid-No.1 Voltage[k] . .	-86	-92	volts
From a grid resistor of .	26,000	27,000	ohms
Peak RF Grid-No.1 Voltage	106	114	volts
DC Plate Current.	125	140	ma
DC Grid-No.2 Current. . .	8.5	9.5	ma
DC Grid-No.1 Current (Approx.)	3.3	3.4	ma
Driving Power (Approx.) .	0.4	0.5	watt
Power Output (Approx.). .	42	62	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance[n] . . . 30,000 max. ohms

RF POWER AMPLIFIER & OSC. – Class C Telegraphy and RF POWER AMPLIFIER – Class C FM Telephony

Maximum Ratings, *Absolute-Maximum Values up to 60 Mc:*

	CCS	ICAS	
DC PLATE VOLTAGE.	600 max.	750 max.	volts
DC GRID-No.2 VOLTAGE. . .	250 max.	250 max.	volts
DC GRID-No.1 VOLTAGE. . .	-150 max.	-150 max.	volts
DC PLATE CURRENT.	175 max.	220 max.	ma
DC GRID-No.1 CURRENT. . .	3.5 max.	4.0 max.	ma
PLATE INPUT	90 max.	120 max.	watts
GRID-No.2 INPUT	3 max.	3 max.	watts
PLATE DISSIPATION	27 max.	35 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode. .	135 max.	135 max.	volts
Heater positive with respect to cathode. .	135 max.	135 max.	volts

Typical Operation as Amplifier up to 60 Mc:

	CCS	ICAS	
DC Plate Voltage.	600	750	volts
DC Grid-No.2 Voltage[l] . .	200	200	volts
DC Grid-No.1 Voltage[m] . .	-70	-77	volts
From a grid-No.1 resistor of	24,000	28,000	ohms
Peak RF Grid-No.1 Voltage	90	95	volts
DC Plate Current.	150	160	ma
DC Grid-No.2 Current. . .	10	10	ma
DC Grid-No.1 Current (Approx.)	2.8	2.7	ma
Driving Power (Approx.) .	0.3	0.3	watt
Power Output (Approx.). .	63	85	watts

Typical Operation as Amplifier at 175 Mc:

	CCS	ICAS	ICAS	
DC Plate Voltage.	320	400	435	volts
DC Grid-No.2 Voltage[l] . .	210	220	230	volts
DC Grid-No.1 Voltage[m] . .	-52	-55	-56	volts
From a grid resistor of .	26,000	30,000	24,000	ohms
Peak RF Grid-No.1 Voltage	65	67	73	volts
DC Plate Current.	170	180	210	ma
DC Grid-No.2 Current. . .	12	12	11	ma
DC Grid-No.1 Current (Approx.)	2	1.9	2.3	ma
Driving Power (Approx.) .	2	2	3	watts
Power Output (Approx.). .	29	40	50	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance[n] . . . 30,000 max. ohms

CHARACTERISTICS RANGE VALUES

	Note	Min.	Max.	
1. Direct Interelectrode Capacitances:				
Grid No.1 to plate . . .	1	-	0.24	pf
Grid No.1 to cathode & grid No.3 & internal shield, base sleeve, grid No.2, and heater.	1	12.0	15.0	pf
Plate to cathode & grid No.3 & internal shield, base sleeve, grid No.2, and heater	1	7.3	9.5	pf
2. Plate Current.	2	46	94	ma
3. Zero-Bias Plate Current. .	3	330	-	ma
4. Grid-No.2 Current.	2	-	5.5	ma

Note 1: With no external shield.

Note 2: With heater voltage of 13.5 volts, dc plate voltage of 400 volts, dc grid-No.2 voltage of 200 volts, and dc grid-No.1 voltage of -34 volts.

Note 3: With heater voltage of 13.5 volts, dc plate voltage of 100 volts, dc grid-No.2 voltage of 200 volts, and dc grid-No.1 voltage of -100 volts. Grid No.1 is square-wave pulsed at 1000 kc to zero volts. Limit value is peak-pulse current.

SPECIAL PERFORMANCE DATA ON HEATER OPERATION

Stationary Equipment Operation:

Heater, for Unipotential Cathode:

	Min.	Design Center	Max.	
Voltage (AC or DC)[a] . . .	-	12.6	-	volts
Current at 12.6 volts. .	0.525	-	0.600	amp
Useful Power Output[b] . . .	59	-	-	watts

[a] It is recommended that the design-center heater voltage be 12.6 volts; the heater power supply should not fluctuate more than 10% to insure long life.

[b] In a single-tube, self-excited oscillator circuit, and with ac heater voltage of 12.6 volts, dc plate voltage of 600 volts, dc grid-No.2 voltage of 200 volts, grid-No.1 resistor of 24,000 ± 10% ohms, dc plate current of 150 max. ma., dc grid-No.1 current of 2.5 to 3 ma., and frequency of 15 Mc.

Mobile Equipment Operation:

Heater, for Unipotential Cathode:

	Min.	Design Range	Max.	
Voltage (AC or DC)[a] . . .	-	12-15	-	volts
Current at 13.5 volts. .	0.550	-	0.620	amp
Useful Power Output I[b] . .	59	-	-	watts
Useful Power Output II . .		See *Note c*		

Overvoltage Heater Life Tests:

Continuous heater life tests are performed periodically on sample lots of tubes with 16 volts on the heater, all other electrodes "floating". Intermittent heater life tests are performed periodically on sample lots of tubes with 22 volts on the heater, a cycle of 1 minute "ON" and 4 minutes "OFF". After 1000 hours of the continuous heater life test and after 48 hours of the intermittent heater life test, the following tests are performed:

With heater voltage of 13.5 volts and ± 100 dc volts between cathode and heater, the heater-cathode leakage current will not exceed 100 microamperes.

With ac or dc heater voltage of 13.5 volts, grid-No.1 volts = -200 and cathode, grid No.2, and plate grounded, the minimum grid-No.1 leakage resistance will be 10 megohms.

With ac or dc heater voltage of 13.5 volts, plate volts = -200, and cathode grid No.1 and grid No.2 grounded, the minimum plate leakage resistance will be 10 megohms.

[a] It is recommended that the heater voltage operate within the range of 12.0 to 15.0 volts and within excursions from 10 to 16 volts in battery operation. See *Useful Power Output Test II* and *Overvoltage Tests*.

[b] In a single-tube, self-excited oscillator circuit, and with ac heater voltage of 12.6 volts, dc plate voltage of 600 volts, dc grid-No.2 voltage of 200 volts, grid-No.1 resistor of 24,000 ± 10% ohms, dc plate current of 150 max. ma., dc grid-No.1 current of 2.5 to 3 ma., and frequency of 15 Mc.

[c] With conditions in note b above, reduce heater voltage to 10 volts. Useful power output will be at least 90% of the power output at heater voltage of 12.6 volts.

[a] With no external shield.

[b] Averaged over any audio-frequency cycle of sine-wave form.

[c] Obtained preferably from a separate source or from the plate voltage supply with a voltage divider.

[d] The driver stage should be capable of supplying the No.1 grids of the class AB_1 stage with the specified driving voltage at low distortion.

[e] The type of input coupling network used should not introduce too much resistance in the grid-No.1 circuit. Transformer or impedance coupling devices are recommended.

[f] Driver stage should be capable of supplying the specified driving power at low distortion to the No.1 grids of the AB_2 stage.

[g] To minimize distortion, the effective resistance per grid-No.1 circuit of the AB_2 stage should be held at a low value. For this purpose the use of transformer coupling is recommended. In no case, however, should the total dc grid-No.1-circuit resistance exceed 30,000 ohms when the tube is operated at maximum ratings. For operation at less than maximum ratings, the dc grid-No.1-circuit resistance may be as high as 100,000 ohms.

[h] Obtained preferably from a separate, well-regulated source.

[i] Referenced to either of the two tones and without the use of feedback to enhance linearity.

[j] Obtained preferably from a separate source modulated with the plate supply, or from the modulated plate supply through a series resistor.

[k] Obtained from grid-No.1 resistor or from a combination of grid-No.1 resistor with either fixed supply or cathode resistor.

[l] Obtained preferably from separate source, or from the plate-supply voltage with a voltage divider, or through a series resistor. A series grid-No.2 resistor should be used only when the tube is used in a circuit which is not keyed. Grid-No.2 voltage must not exceed 435 volts under key-up conditions.

[m] Obtained from fixed-supply, by grid-No.1 resistor, by cathode resistor, or by combination methods.

[n] When grid No.1 is driven positive and the tube is operated at maximum ratings, the total dc grid-No.1-circuit resistance should not exceed the specified value of 30,000 ohms. If this value is insufficient to provide adequate bias, the additional required bias must be supplied by a cathode resistor or fixed supply. For operations at less than maximum ratings, the dc grid-No.1-circuit resistance may be as high as 100,000 ohms.

DEFINITIONS

AB_1 - The subscript 1 indicates that grid-No.1 current does not flow during any part of the input cycle.

AB_2 - The subscript 2 indicates that grid-No.1 current flows during some part of the input cycle.

CCS - Continuous Commercial Service.

ICAS - Intermittent Commercial and Amateur Service.

Ratings System - The *maximum ratings* in the tabulated data are established in accordance with the following defination of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

Two-Tone Modulation - Two-Tone Modulation operation refers to that class of amplifier service in which the input consists of two monofrequency rf signals having equal peak amplitude.

MAXIMUM RATINGS vs. OPERATING FREQUENCY
In Class C Telegraphy Service

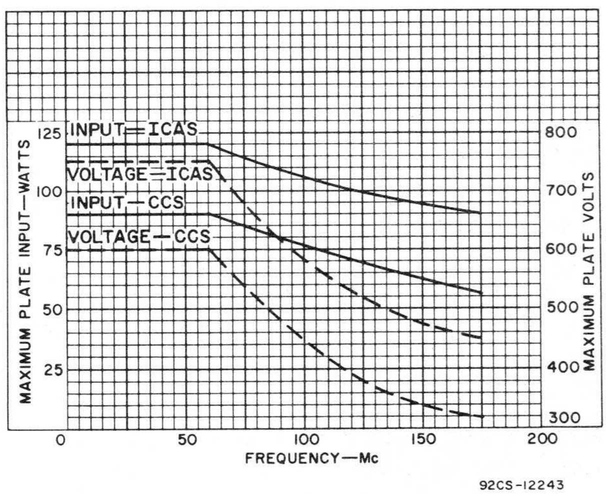


Fig.1A

MAXIMUM RATINGS vs. OPERATING FREQUENCY
In Class C Telephony Service

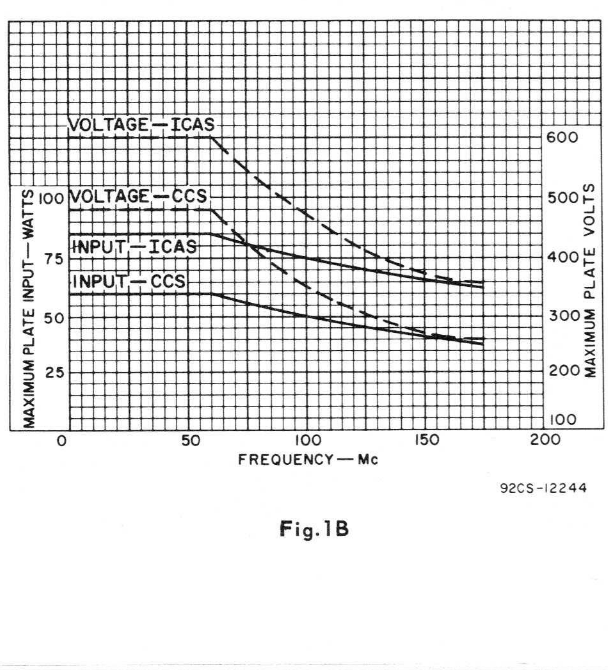


Fig.1B

GENERAL CONSIDERATIONS

Temperature

The maximum bulb temperature of 260° C is a tube rating and is to be observed in the same manner as other ratings. The temperature may be measured with temperature-sensitive paint, such as Tempilaq. The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, N. Y.

MECHANICAL CONSIDERATIONS

Plate Circuit

Heavy leads and conductors together with suitable insulation should be used in all parts of the rf plate tank circuit so that losses due to rf voltages and currents may be kept at a minimum. At the higher frequencies, it is essential that short, heavy leads be used for circuit connections in order to minimize lead inductance and losses.

TYPICAL PLATE CHARACTERISTICS

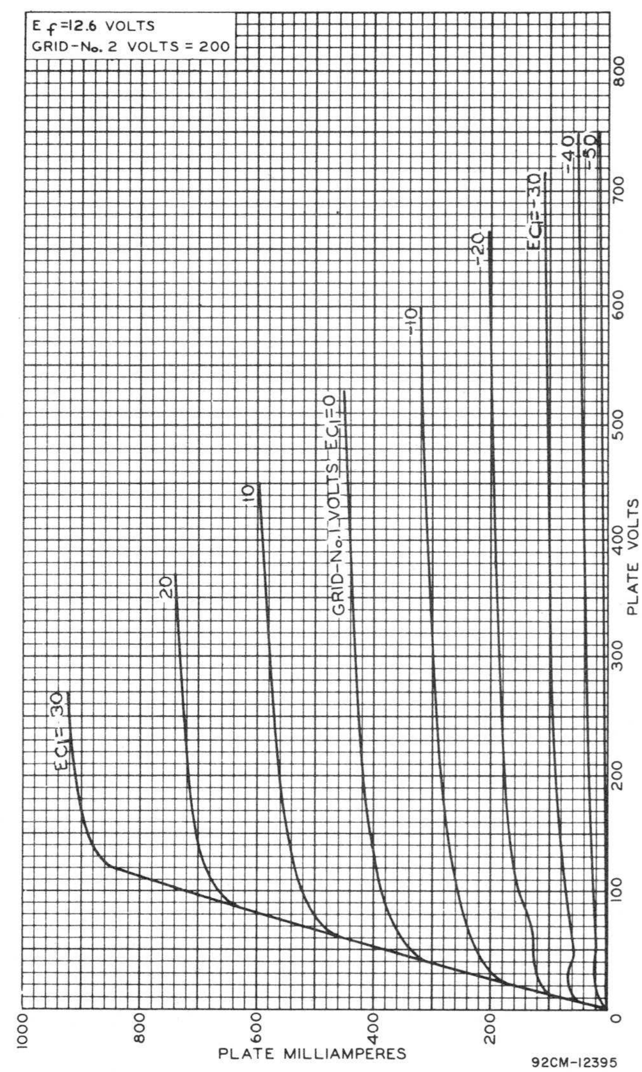


Fig.2

TYPICAL CHARACTERISTICS

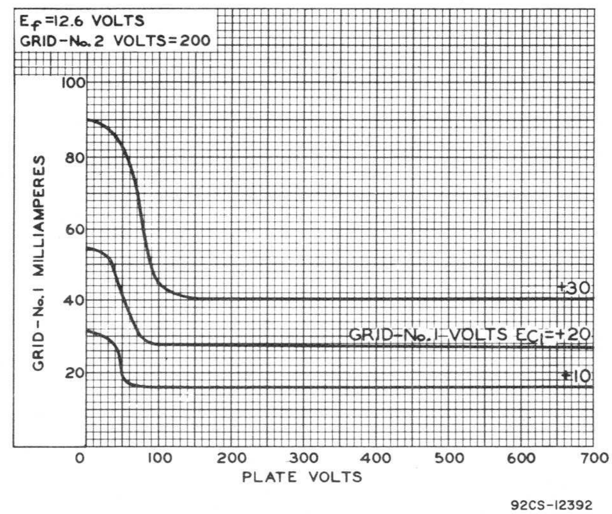


Fig.3

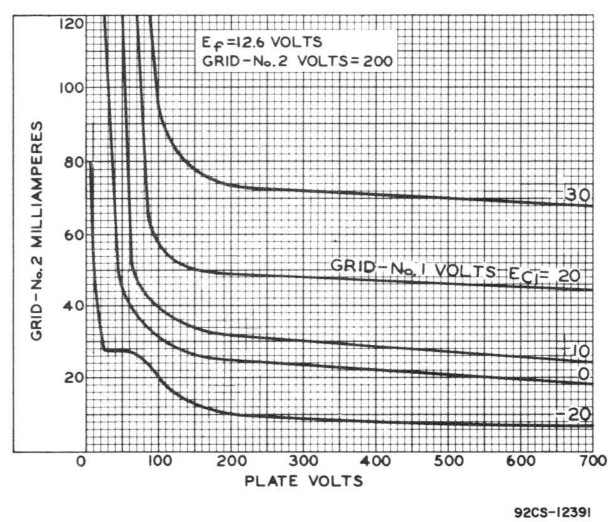


Fig. 4

To insure adequate cooling it is essential that free circulation of air be provided around the tube. In most cases, no additional air is required.

Plate Color

The plate shows no color when the 6883B is operated at full ratings under either CCS or ICAS conditions.

Connections to the plate should be made with a flexible lead to prevent any strain on the seal at the cap.

ELECTRICAL CONSIDERATIONS

Plate and Grid No.2

When a new circuit is tried or when adjustments are made, it is advisable to reduce the plate voltage and grid-No. 2 voltage. If the 6883B is operated at maximum-ratings and grid-No. 2 voltage is obtained through a series dropping resistor, the use of a 2500-ohm protective resistor in the high-voltage supply lead is recommended. When a separate grid-No. 2 voltage supply is used, a 10,000-ohm protective resistor should be connected in the grid-No. 2 supply lead.

The grid-No. 2 current is a very sensitive indication of plate-circuit loading and grid-No. 2 current rises excessively (often to the point of damaging the tube) when the amplifier is operated without load. Therefore, care should be taken when tuning a 6883B under no-load conditions in order to prevent exceeding the grid-No. 2 input rating of the tube.

TYPICAL PLATE CHARACTERISTICS

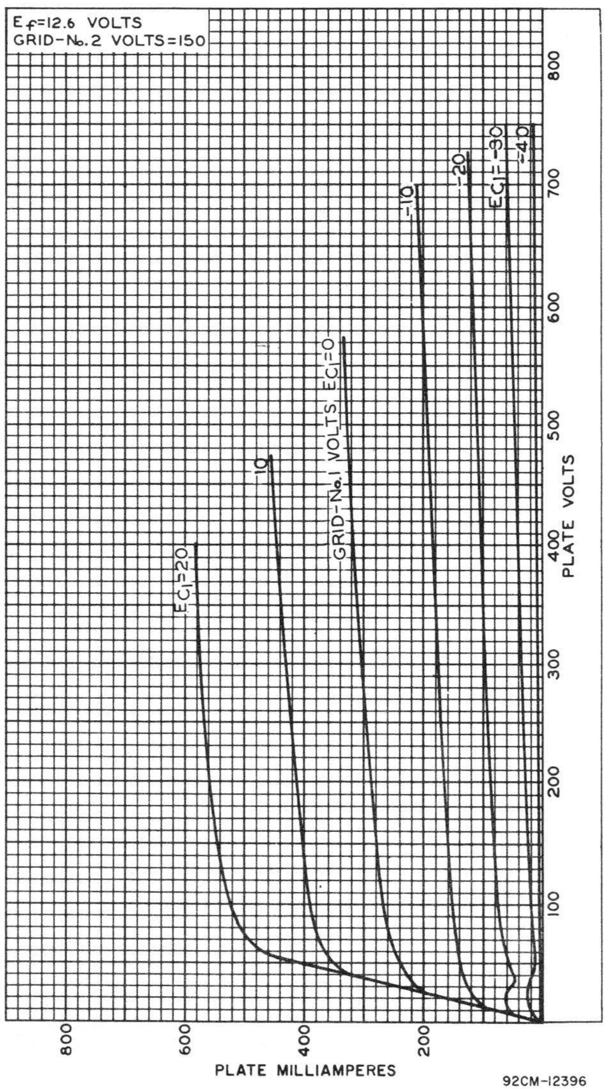


Fig.5

TYPICAL CHARACTERISTICS

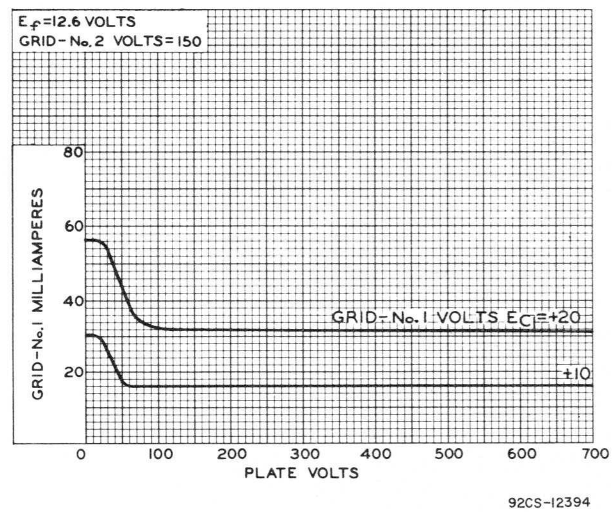


Fig.6

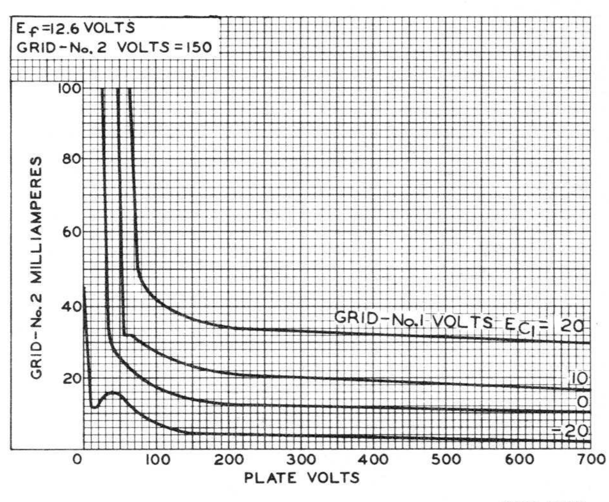


Fig.7

The plate voltage should be applied before or simultaneously with the grid-No. 2 voltage; otherwise, with voltage on grid No. 2 only, its current may be large enough to cause excessive grid-No. 2 dissipation. A dc milliammeter should be used in the grid-No. 2 circuit so that its current may be measured and the dc power input determined.

Driver

The driver stage for the 6883B in either class C telephony or telegraphy service should have considerably more output capability than the typical driving power shown in the tabulated data in order to permit considerable range of adjustment, and also to provide for losses in the grid-No. 1 circuit and the coupling circuits. This recommendation is particularly important near the maximum-rated frequency where there are other losses of driving power, such as circuit losses, radiation losses, and transit-time losses.

Efficiency

Highest operating efficiency in high-frequency service, and therefore maximum power output, will be obtained when the 6883B is operated under load conditions such that the maximum rated plate current flows at the plate voltage which will give maximum rated input.

Class C Telephony

In plate-modulated class C amplifier service, the 6883B can be modulated 100 per cent. The grid-No.2 voltage must be modulated simultaneously with the plate voltage so that the ratio of grid-No.2 voltage to plate voltage remains constant. Modulation of the grid-No.2 voltage can be accomplished either by connecting grid No.2 through a separate winding on the modulation transformer to the fixed grid-No.2 voltage supply, or by connecting grid No.2 through an audio-frequency choke of suitable impedance for low audio frequencies to the fixed grid-No.2 supply voltage. The supply end of the choke should be well bypassed to ground.

Circuit Arrangements

Push-pull or parallel circuit arrangements can be used when more radio-frequency power is required than can be obtained from a single 6883B. Two 6883B's in parallel or push-pull will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage necessary to drive a single tube.

With either connection, the driving power required is approximately twice that for a single tube. The push-pull arrangement has the advantage of simplifying the balancing of high-frequency circuits.

When two or more tubes are used in the circuit, precautions should be taken to insure that each tube draws the same plate current.

Standby Operation

During standby periods in intermittent operation, the heater voltage may be maintained at normal operating value for most applications.

In those applications which require maximum reliability, it is recommended that the heater voltage be maintained at normal operating value when the period is less than 15 minutes; that it be reduced to 80 per cent of normal when the period is between 15 minutes and 2 hours; and that for longer periods, the heater voltage should be turned off.

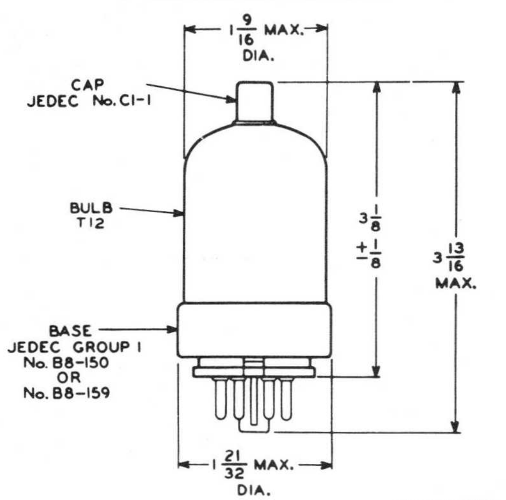
Protective Devices

Protective devices should be used to protect not only the plate but also grid No.2 against overload. In order to prevent excessive plate current flow and resultant overheating of the tube, the common ground lead of the plate circuit should be connected in series with the coil of an instantaneous overload relay. This relay should be adjusted to remove the dc plate and grid-No.2 voltage when the average value of plate current reaches a value slightly higher than normal plate current. A protective device in the grid-No.2 supply should remove the grid-No.2 voltage when the dc grid-No.2 current reaches a value slightly higher than normal.

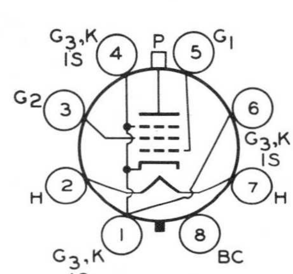
Precautions

The rated plate and grid-No.2 voltages of this tube are extremely dangerous. Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel can not possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies when any gate or door on the protective housing is opened, and should prevent the closing of the primary circuit until the door is again locked.

DIMENSIONAL OUTLINE



TERMINAL CONNECTIONS
Bottom View



7CK

PIN 1: CATHODE, GRID No.3, INTERNAL SHIELD
PIN 2: HEATER
PIN 3: GRID No.2
PIN 4: SAME AS PIN 1
PIN 5: GRID No.1
PIN 6: SAME AS PIN 1
PIN 7: HEATER
PIN 8: BASE SLEEVE
CAP: PLATE

CERMOLOX

Oxide-Coated Cathode

Forced-Air Cooled

80 Watts CW Power Output at 400 MHz

40 Watts CW Power Output at 1215 MHz

RCA-6884

BEAM POWER TUBE

RCA-6884 is a very small, forced-air cooled uhf beam power tube designed for use in compact aircraft, mobile and stationary equipment. It is rated as an af power amplifier and modulator and to frequencies up to 1215 MHz as a linear rf power amplifier in single-sideband suppressed-carrier service, as a plate-modulated rf power amplifier in Class C telephony service, as an rf power amplifier and oscillator in Class C telegraphy service, and as an rf power amplifier in Class C FM telephony service.

The 6884 and variants of its basic design may also be useful in applications such as frequency multipliers, linear rf power amplifiers (AM or television), pulse modulators, pulsed-rf amplifiers, regulators, or other special services. Variations in cooling structure or parameters are also possible. For information on variants, contact your RCA field representative.

The 6884 features the Cermolox construction, a unipotential cathode of the oxide-coated type, and an integral stacked-disc-type finned radiator. Details of these features are described in the **Application Guide for RCA Power Tubes, 1CE-300.**

INDEX

*This bulletin is to be used in conjunction with the publication, Application Guide for RCA Power Tubes, 1CE-300. For a copy, write RCA, Commercial Engineering, Harrison, N.J.

▲Erie Technological Products, Inc., 2206 West 15th Street, Erie, Pennsylvania

■E.F. Johnson Co., 299 10th Ave., S.W., Waseca, Minn.

GENERAL DATA

Electrical:

Heater for Oxide-Coated Unipotential Cathode:		
Voltage (ac or dc)	26.5 typical	volts
	29.2 max.	volts
Current at 26.5 volts	0.54	A
Minimum heating time	1	minute

See further information on the heater in **Application Guide for RCA Power Tubes, 1CE-300;** *Section V.A.3,* **Filament or Heater.**

Mu-Factor, Grid No.2 to Grid No.1	18	
Direct Interelectrode Capacitances[a]:		
Grid No.1 to plate	0.065 max.	pF
Grid No.1 to cathode & heater	13	pF
Plate to cathode & heater	.013 max.	pF
Grid No.1 to grid No.2	18	pF
Grid No.2 to plate	4.8	pF
Grid No.2 to cathode & heater	0.45 max.	pF

Mechanical:

Operating Position	Any
Overall Length	1.93" max.
Greatest Diameter	1.265" max.
Terminal Connections	See *Dimensional Outline*

For operation up to 400 MHz

Socket, including Grid-No.2 Bypass Capacitor . . . . Erie▲ 2948-000, E.F. Johnson■ DN124-152-1, Jettron● 89-001, or equivalent

Grid-No.2 Bypass Capacitor . . . . Erie▲ 2926-000, 2929-001, or equivalent

For operation at high frequencies

See Preferred Mounting Arrangement	Page 4
Radiator	Integral part of tube
Weight (Approx.)	2 oz.

Thermal:

Terminal Temperature (Plate, grid No.2, grid No.1, cathode, and heater)	250 max. °C
Plate-Core Temperature	250 max. °C

See Dimensional Outline for temperature-measurement points

●Jettron Products, Inc., 56 Rt. 10, Hanover, N.J.

RADIO CORPORATION OF AMERICA
Electronic Components and Devices Harrison, N. J.

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Printed in U.S.A.
Supersedes 6816 8/60 6884 8/66

AF POWER AMPLIFIER & MODULATOR—Class AB_1[b]

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC Plate Voltage	1000 max. volts
DC Grid-No.2 Voltage	300 max. volts
Max.-Signal DC Plate Current	180 max. mA
Max.-Signal Plate Input	180 max. watts
Max.-Signal Grid-No.2 Input	4.5 max. watts
Plate Dissipation	115 max. watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance under Any Condition:

With fixed bias	30000 max. ohms
With cathode bias	Not recommended

Typical CCS Operation:

Values are for 2 tubes

DC Plate Voltage	650	850	volts
DC Grid-No.2 Voltage	300	300	volts
DC Grid-No.1 Voltage:			
From fixed-bias source	−15	−15	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	30	30	volts
Zero-Signal DC Plate Current	80	80	mA
Max.-Signal DC Plate Current	200	200	mA
Zero-Signal DC Grid-No.2 Current	0	0	mA
Max.-Signal DC Grid-No.2 Current	20	20	mA
Effective Load Resistance (Plate to plate)	4330	7000	ohms
Max.-Signal Driving Power (Approx.)	0	0	watts
Max.-Signal Power Output (Approx.)	50	80	watts

AF POWER AMPLIFIER & MODULATOR—Class AB_2[b]

Maximum CCS Ratings, *Absolute-Maximum Values:*

DC Plate Voltage	1000 max. volts
DC Grid-No.2 Voltage	300 max. volts
Max.-Signal DC Plate Current	180 max. mA
Max.-Signal DC Grid-No.1 Current	30 max. mA
Max.-Signal Plate Input	180 max. watts
Max.-Signal Grid-No.2 Input	4.5 max. watts
Plate Dissipation	115 max. watts

Typical CCS Operation:

Values are for 2 tubes

DC Plate Voltage	650	850	volts
DC Grid-No.2 Voltage	300	300	volts
DC Grid-No.1 Voltage:			
From fixed-bias source	−15	−15	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	46	46	volts
Zero-Signal DC Plate Current	80	80	mA
Max.-Signal DC Plate Current	355	355	mA
Zero-Signal DC Grid-No.2 Current	0	0	mA
Max.-Signal DC Grid-No.2 Current	25	25	mA
Max.-Signal DC Grid-No.1 Current	15	15	mA
Effective Load Resistance (Plate to plate)	2450	3960	ohms
Max.-Signal Driving Power (Approx.)	0.3	0.3	watt
Max.-Signal Power Output (Approx.)	85	140	watts

PLATE-MODULATED RF POWER AMPLIFIER—Class C Telephony[b]

Carrier conditions per tube for use with a max. modulation factor of 1.0

Maximum CCS Ratings, *Absolute-Maximum Values*

	Up to 1215 MHz:
DC Plate Voltage	800 max. volts
DC Grid-No.2 Voltage	300 max. volts
DC Grid-No.1 Voltage	−100 max. volts
DC Plate Current	150 max. mA
DC Grid-No.1 Current	30 max. mA
Plate Input	120 max. watts
Grid-No.2 Input	3 max. watts
Plate Dissipation	75 max. watts

Typical CCS Operation:

	At 400 MHz:		
DC Plate Voltage	400	700	volts
DC Grid-No.2 Voltage	200	250	volts
DC Grid-No.1 Voltage	−20	−50	volts
DC Plate Current	100	130	mA
DC Grid-No.2 Current	5	10	mA
DC Grid-No.1 Current	5	10	mA
Driver Power Output (Approx.)	2	3	watts
Useful Power Output (Approx.)	16	45	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance under Any Condition	30000 max. ohms

RF POWER AMPLIFIER & OSCILLATOR—Class C Telegraphy[b] and RF POWER AMPLIFIER—Class C FM Telephony

Maximum CCS Ratings, *Absolute-Maximum Values:*

	Up to 1215 MHz:
DC Plate Voltage	1000 max. volts
DC Grid-No.2 Voltage	300 max. volts
DC Grid-No.1 Voltage	−100 max. volts
DC Plate Current	180 max. mA
DC Grid-No.1 Current	30[f] max. mA
Plate Input	180 max. watts
Grid-No.2 Input	4.5 max. watts
Plate Dissipation	115 max. watts

Typical CCS Operation:

	At 400 MHz		*At 1215 MHz*	
DC Plate Voltage	400	900	900	volts
DC Grid-No.2 Voltage	200	300	300	volts
DC Grid-No.1 Voltage	−35	−30	−22	volts
DC Plate Current	150	170	170	mA
DC Grid-No.2 Current	5	1	1	mA
DC Grid-No.1 Current	3	10	4	mA
Driver Power Output (Approx.)	3	3	5	watts
Useful Power Output (Approx.)	23	80	40	watts

Maximum Circuit Values:

Grid-No.1- Circuit Resistance under Any Condition	3000 max. ohms

LINEAR RF POWER AMPLIFIER, Class AB_1[b]

Single-Sideband Suppressed-Carrier Service

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2

Maximum CCS Ratings, *Absolute-Maximum Values:*

	Up to 1215 MHz	
DC Plate Voltage	1000	max. volts
DC Grid-No.2 Voltage	300	max. volts
DC Grid-No.1 Voltage	–100	max. volts
DC Plate Current at Peak of Envelope	250[c]	max. mA
DC Grid-No.1 Current	30	max. mA
Plate Input	180	max. watts
Grid-No.2 Input	4.5	max. watts
Plate Dissipation	115	max. watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Condition:		
With fixed bias	25000	max. ohms
With fixed bias (In Class AB_1 operation)	100000	max. ohms
With cathode bias	Not recommended	
Grid-No.2 Circuit Impedance	See Note **d**	
Plate Circuit Impedance	See Note **e**	

Typical CCS Operation with "Two-Tone" Modulation:

	At 30 MHz		
DC Plate Voltage	650	850	volts
DC Grid-No.2 Voltage	300	300	volts
DC Grid-No.1 Voltage	–18.5	–18.5	volts
Zero-Signal DC Plate Current	40	40	mA
Effective RF Load Resistance	2200	3500	ohms
DC Plate Current at Peak of Envelope	100	100	mA
Average DC Plate Current	75	75	mA
DC Grid-No.2 Current at Peak of Envelope	8.2	4.2	mA
Average DC Grid-No.2 Current	3.6	1.7	mA
Peak-Envelope Driver Power Output (Approx.)	0.5	0.5	watt
Output-Circuit Efficiency (Approx.)	90	90	%
Distortion Products Level:			
Third Order	35	30	dB
Fifth Order	40	36	dB
Useful Power Output (Approx.):			
Average	12.5	20	watts
Peak envelope	25	40	watts

FOOTNOTES for *General Data and Ratings*

[a] Measured with special shield adapter.

[b] See Section V.C. of 1CE-300.

[c] The maximum rating for a signal having a minimum peak-to-average power ratio less than 2, such as is obtained in "Single-Tone" operation, is 180 mA. During short periods of circuit adjustment under "Single-Tone" conditions, the average plate current may be as high as 250 mA.

[d] See Section V.B. 2 of 1CE-300.

[e] See Section V.B.1 of 1CE-300.

[f] In applications where the frequency is less than 80 MHz and the bias is less than –50 volts, the maximum value is 40 mA.

CHARACTERISTICS RANGE VALUES

	Note	*Min.*	*Max.*	
1. Heater Current	1	0.48	0.60	A
2. Direct Interelectrode Capacitances:				
Grid No.1 to plate	2	–	0.065	pF
Grid No.1 to cathode & heater	2	11.0	15.0	pF
Plate to cathode & heater	2	–	0.013	pF
Grid No.1 to grid No.2	2	15.0	20.0	pF
Grid No.2 to plate	2	4.2	5.2	pF
Grid No.2 to cathode & heater	2	0.20	0.45	pF
3. Grid-No.1 Voltage	1,3	–6	–15	volts
4. Grid-No.1 Cutoff Voltage	1,4	–	–48	volts
5. Grid-No.1 Current	1,5	6	–	mA
6. Reverse Grid-No.1 Current	1,3	–	8	µA
7. Grid-No.2 Current	1,3	–8	+2.0	mA
8. Peak Emission	1,6	–	300	peak volts
9. Interelectrode Leakage Resistance	7	1.0	–	megohm
10. Useful Power Output	8	80	–	watts

NOTE 1: With 26.5 volts ac or dc on heater.

NOTE 2: Measured with special shield adapter.

NOTE 3: With dc plate voltage of 1000 volts, dc grid-No.2 voltage of 300 volts, and dc grid-No.1 voltage adjusted to give a dc plate current of 115 mA.

NOTE 4: With dc plate voltage of 1000 volts, dc grid-No.2 voltage of 300 volts, and dc grid-No.1 voltage adjusted to give a dc plate current of 1 mA.

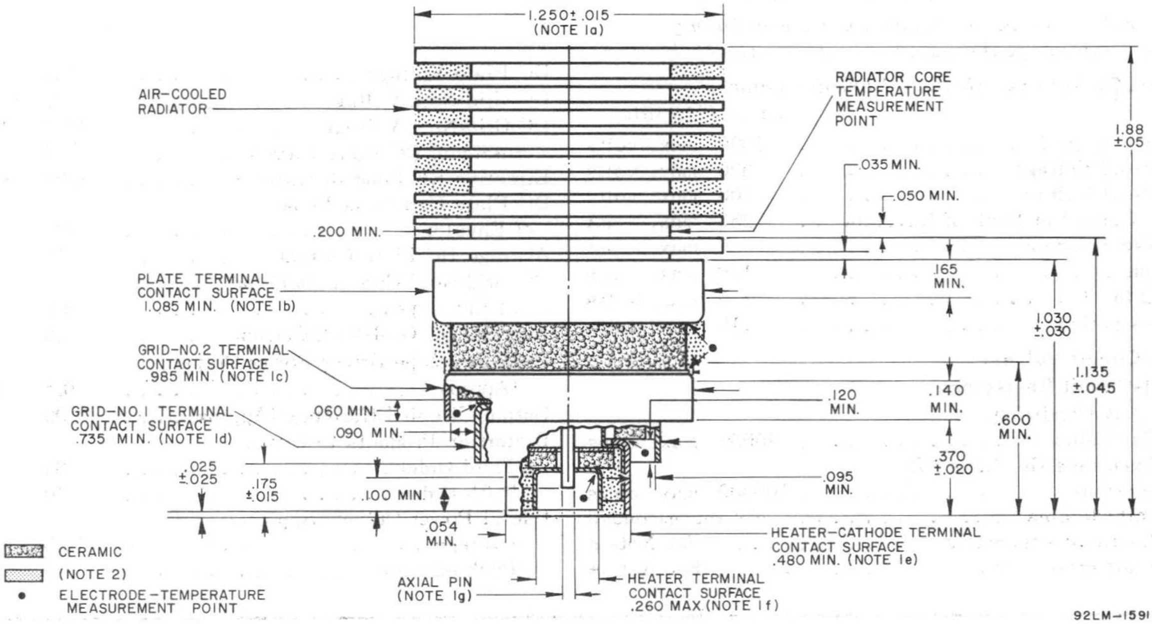
NOTE 5: With plate and grid-No.2 floating and dc grid-No.1 voltage of +2 volts.

NOTE 6: With grid No.1, grid No.2, and plate tied together; and pulse voltage source connected between plate and cathode. Pulse duration is 2 microseconds, pulse repetition frequency is 60 pps, and duty factor is 0.00012. The voltage-pulse amplitude is adjusted until a peak cathode current of 10 amperes is obtained. After 1 minute at this value, the voltage-pulse amplitude will not exceed 300 volts (peak).

NOTE 7: With tube at 20° to 30° C for at least 30 minutes without any voltages applied to the tube. The minimum resistance between any two adjacent electrodes as measured with a 200-volt Megger-type ohmmeter having an internal impedance of 1.0 megohm, will be 1.0 megohm.

NOTE 8: In a single-tube, grid-driven coaxial-cavity class C amplifier circuit at 400 MHz and for conditions with 24.0 volts ac or dc on heater, dc plate voltage of 1000 volts, dc grid-No.2 voltage of 300 volts, grid-No.1 resistor adjustable between zero and 10000 ohms, dc plate current of 180 mA maximum, dc grid-No.1 current of 30 mA maximum and driver power output of 3 watts.

DIMENSIONAL OUTLINE



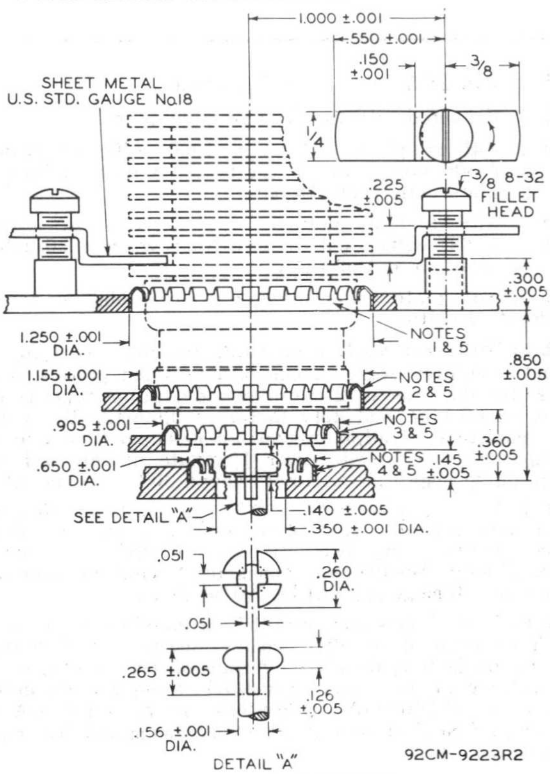
DIMENSIONS IN INCHES

NOTE 1: The following diametrical space requirements accommodate the concentricity of the cylindrical surfaces of the radiator fins, axial pin, and each electrode terminal:

a. Radiator Band – 1.316"
b. Plate Terminal – 1.119"
c. Grid-No.2 Terminal – 1.019"
d. Grid-No.1 Terminal – 0.764"
e. Heater-Cathode Terminal – 0.519"
f. Heater Terminal – 0.240"
g. Axial Pin – 0.071"

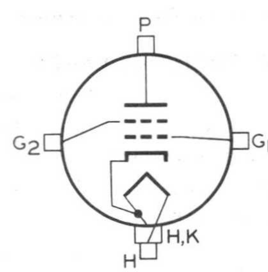
NOTE 2: Keep all stippled regions clear. Do not allow contacts or circuit components to protrude into these annular volumes.

PREFERRED MOUNTING ARRANGEMENT



DIMENSIONS IN INCHES

TERMINAL DIAGRAM



See Dimensional Outline for Terminal Connections

NOTE 1: Contact ring No.97-252 or finger stock No.97-380.

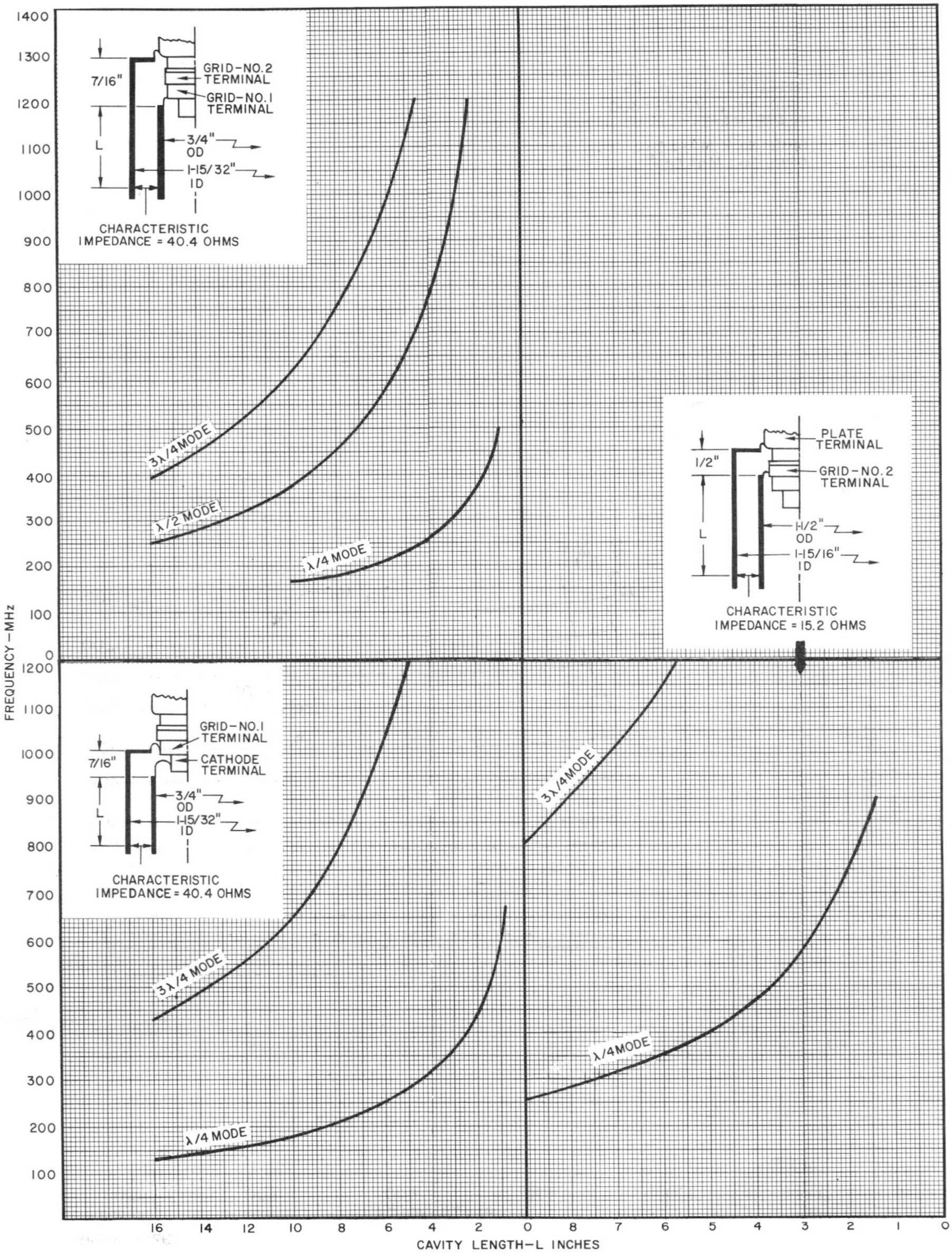
NOTE 2: Contact ring No.97-253 or finger stock No.97-380.

NOTE 3: Contact ring No.97-254 or finger stock No.97-380.

NOTE 4: Contact ring No.97-255 or finger stock No.97-380.

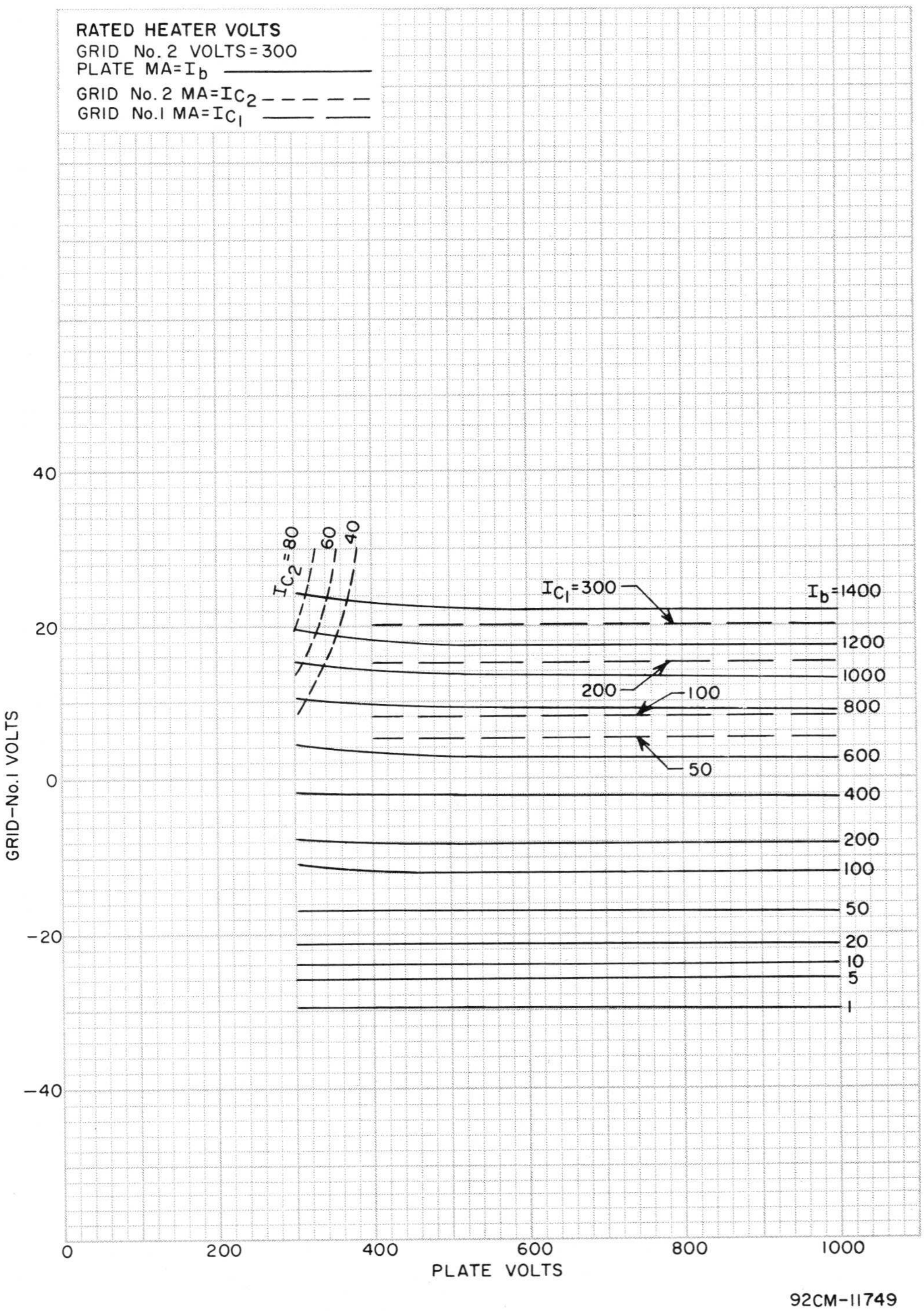
NOTE 5: The specified contact ring of preformed finger stock and finger stock No.97-380 provide adequate electrical contact, but the finger stock No.97-380 is less susceptible to breakage than the specified contact ring. Both types are made by Instruments Specialties Co., Little Falls, N.J.

TUNING CHARACTERISTICS



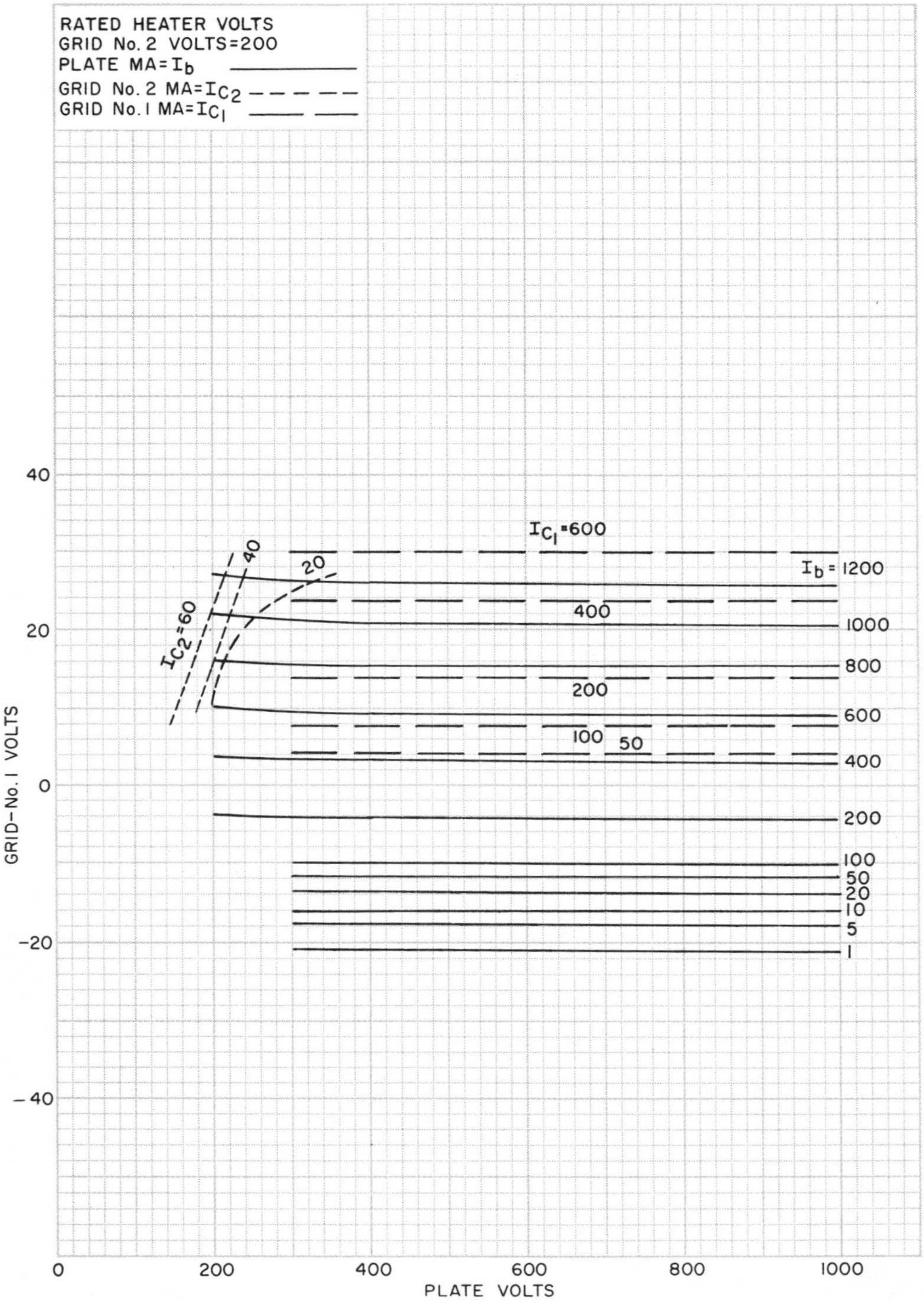
92LL-1582

TYPICAL CONSTANT-CURRENT CHARACTERISTICS
With Grid-No.2 Volts = 300



TYPICAL CONSTANT-CURRENT CHARACTERISTICS

With Grid-No.2 Volts = 200



92CM-11745

FORCED-AIR COOLING

Air Flow:

Through radiator — Adequate air flow to limit the radiator core temperature to 250° C should be delivered by a blower across the radiator before and during the application of plate, grid-No.2, and grid-No.1 voltages. Typical values of air flow directed across the radiator versus plate dissipation are shown in two graphs under *Typical Cooling Requirements*.

To Plate, Grid-No.2, Grid-No.1, Cathode, and Heater Terminals — A sufficient quantity of air should flow across each of these terminals so that their temperature does not exceed the specified maximum value of 250° C.

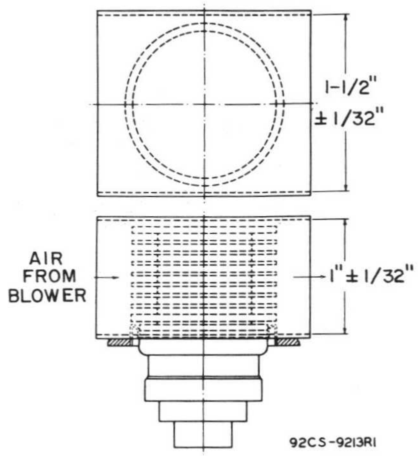
During Standby Operation — Cooling air is not normally required when only heater voltage is applied to the tube.

Plate power, grid-No.2 power, heater power, and air flow may be removed simultaneously.

At sea level cooling requirements with air flow directed across the radiator with cowling as indicated may be met by use of blowers and associated motors manufactured by Rotron Mfg. Co., Inc., Woodstock, N.Y., or equivalent.

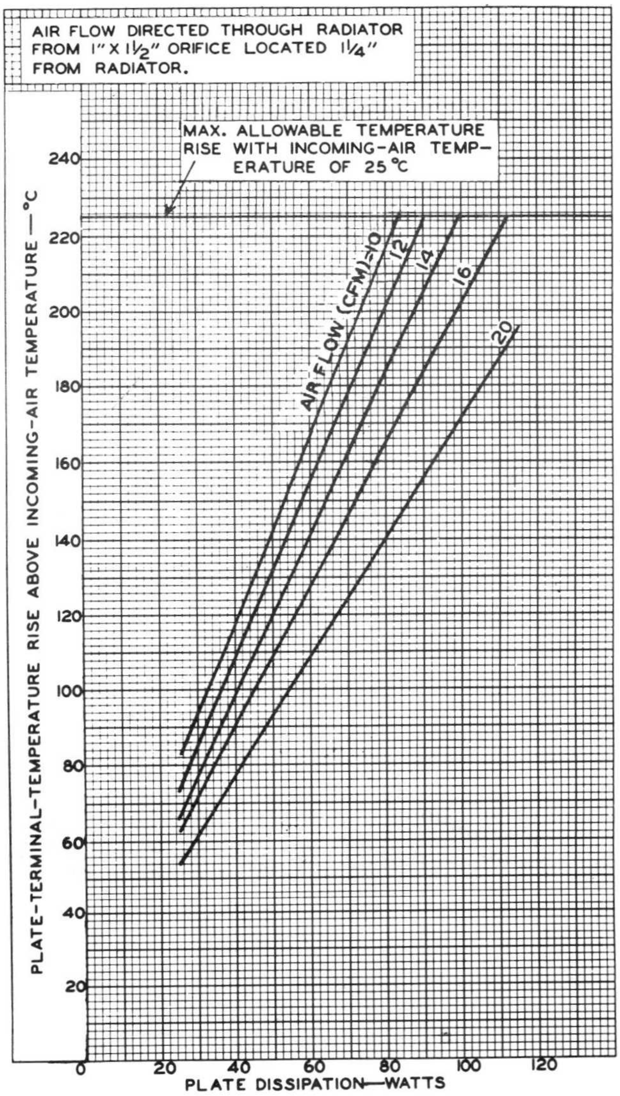
RECOMMENDED COWLING

For Directing Air Flow Through Radiator

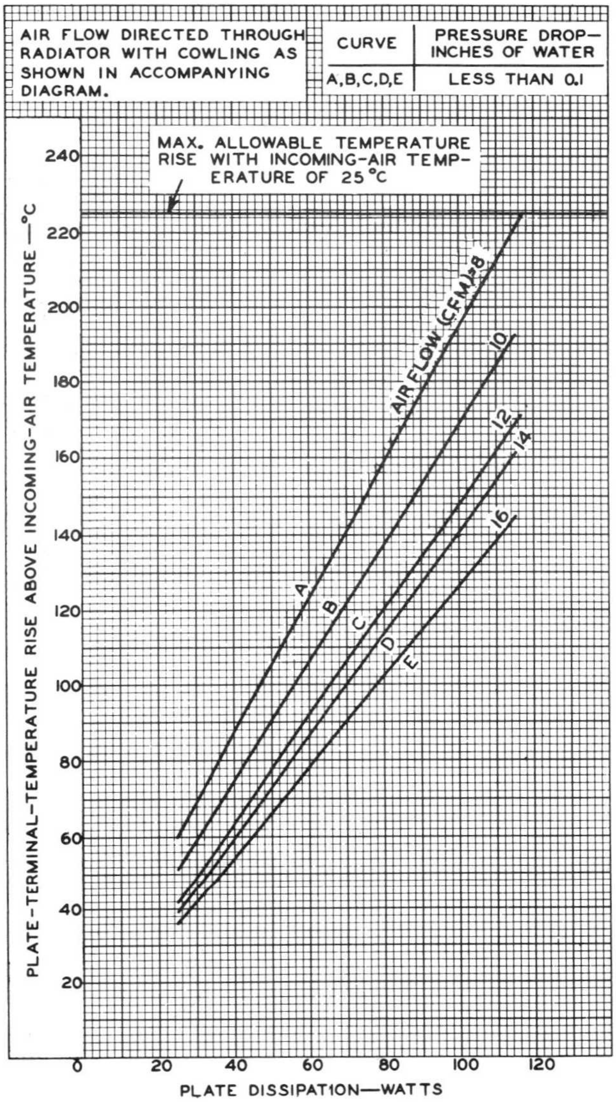


92CS-9213R1

TYPICAL COOLING REQUIREMENTS



92CM-9220R1



92CM-9219R1

This bulletin also applies to RCA-6914A which is identical with RCA-6914 except for the additional special-performance test shown on page 4.

The 6914A is Unilaterally Interchangeable with the 6914.

6914A

6914

IMAGE-CONVERTER TUBE

Electrostatic Focus	Monovoltage Type	2.975" Max. Length
High Resolution	S-1 Response	1.905" Max. Diameter

RCA-6914 is a self-focusing image-converter tube useful in combination with suitable optical systems for viewing a scene irradiated with near-infrared radiation. It utilizes a semitransparent photocathode at one end on which the scene to be viewed is focused by means of an optical objective. The image on the photocathode is electrostatically focused on the fluorescent screen at the other end of the tube by electron-optical methods to form a reduced image which can be viewed with an optical magnifier. The inverted image produced by the optical system on the photocathode is reinverted by the 6914 to give an observed image that is erect.

The 6914 is a monovoltage type, i.e., it operates with only a single voltage applied between its two terminals, and remains in focus with any applied voltage in the operating range from 8000 to 16000 volts. The voltage may be obtained from an unregulated rectified-power supply without a bleeder. Filtering can be provided by a single capacitor. Its value should be such as to provide a high ratio of average dc voltage to ripple voltage in order to obtain the highest average voltage, and hence the highest screen brightness, without exceeding the maximum voltage rating of the tube. Under typical viewing conditions, the value of operating power is about 10 milliwatts at 16000 volts.

Features of the 6914 include a high ratio of light output to infrared-energy input, a minimum resolution of 25 line-pairs per millimeter at the center of the photocathode, and low pincushion distortion. These features, together with those of small size, low power requirements, and self-focusing over a wide range of operating voltage, make the 6914 especially useful in portable equipment.

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Photocathode, Semitransparent:	
Shape	Convexo-Concave ←
Minimum useful diameter	1.000"
Fluorescent Screen:	
Shape	Plano-Plano ←
Minimum useful diameter	0.860"
Phosphor	P20, Aluminized
Fluorescence	Yellow-Green
Phosphorescence	Yellow-Green
Persistence	Medium-Short
Focusing Method (Self-focusing)	Electrostatic
Overall Length	2.925" ± 0.050"
Greatest Diameter	1.880" ± 0.025"
Terminals	See *Dimensional Outline*
Operating Position	Any
Weight (Approx.)	3 oz

Maximum Ratings, ***Absolute-Maximum Values:*** [a]

For altitude up to 10000 feet

ANODE VOLTAGE:[b]		
Average (DC)	16000 max.	volts
Peak Instantaneous	17000 max.	volts
AVERAGE PHOTOCATHODE CURRENT (Continuous operation)[c]	0.35 max.	μA
PEAK PHOTOCATHODE CURRENT[d]	3.5 max.	μA
AMBIENT-TEMPERATURE RANGE	-54 to +68	°C

Characteristics at Ambient Temperature of 22° C:

Anode Voltage (DC)[b]	16000	volts
Typical Paraxial Magnification Factor[e]	0.76	
Minimum Conversion Index[f]	15	
Minimum Resolution[g]	25	line-pairs per mm
Maximum Quotient[h] of Screen Background by Conversion Index	2.5×10^{-7}	lumen/cm^2

[a] The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in device characteristics.

← Indicates a change.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

b Referred to photocathode.

c Averaged over any interval of 10 seconds maximum.

d The 6914 and the 6914A should not be subjected to this peak photocathode current value more than 10 times during the useful life of the tubes. No single time period during which this current is drawn should exceed 2 minutes.

e Defined as the ratio of the linear size of the image on the fluorescent screen to the linear size of the image on the photocathode. The image on the photocathode consists of two parallel lines 0.08" long, each located 0.10" from the tube axis. Size of the image on the fluorescent screen is determined by measuring the spacing between the two parallel lines.

f Ratio of luminous flux from fluorescent screen to the product of the luminous flux incident on Corning No.2540 Infrared Filter (Melt No.1613, 2.61 mm thick), or equivalent, and the filter factor of 11.6 per cent. The light source is a tungsten-filament lamp operated at a color temperature of 2870° K.

g The resolution, both horizontally and vertically in a 0.24-inch-diameter circle centered on the photocathode, is determined with a pattern consisting of alternate black and white lines of equal width. Any two adjacent lines are designated as a "line-pair".

h The value of this quotient for any individual tube multiplied by the square of the magnification factor of the tube gives that value of the incident illumination from a 2870° K source required to produce an increase in screen brightness equal to the screen background.

OPERATING CONSIDERATIONS

Handling. The 6914 should be handled by the metal terminals. Fingerprints on the glass should be avoided since they cause leakage current, corona, and higher screen background. To minimize the possibility of leakage current and corona, the external surface of the glass side wall is coated with a transparent, non-hygroscopic film. This film should be cleaned only with a soft dry cloth.

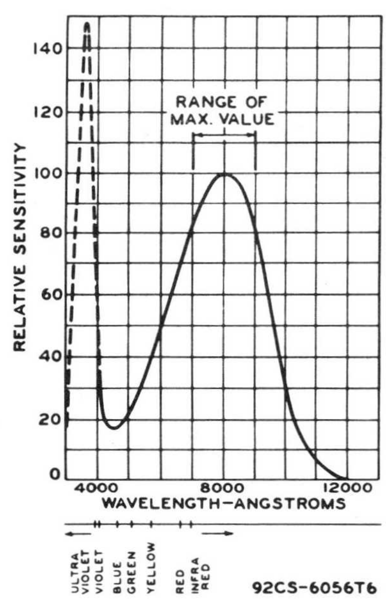


Fig.1 - Spectral Sensitivity Characteristic of Type 6914 which has S-1 Response. Curve is shown for Equal Values of Radiant Power at All Wavelengths.

The *spectral response* of the 6914 is shown by the curve of Fig.1.

The *fluorescent screen* employs the fine-grain phosphor P20 which fluoresces to produce a yellow-green luminescence. It has good visual qualities as well as high luminous efficiency. The spectral-energy emission characteristic of phosphor P20 is shown in Fig.2 and its persistence characteristic in Fig.3.

COLOR	C.I.E. COORDINATES	
	X	Y
YELLOW-GREEN	0.426	0.546

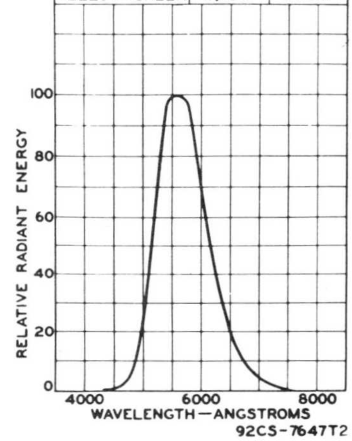


Fig.2 - Spectral-Energy Emission Characteristic of Phosphor P20.

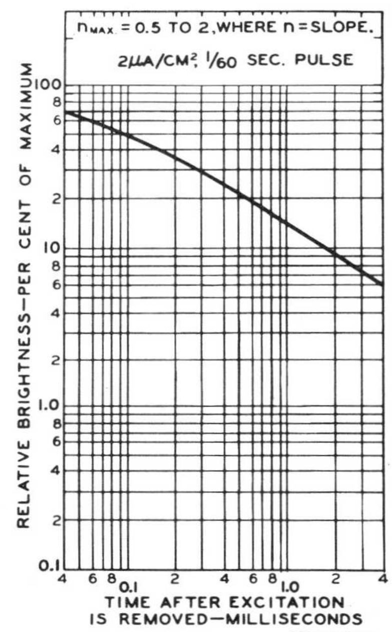


Fig.3-Persistence Characteristic of Phosphor P20.

The *light output* from the 6914 as a function of anode voltage is given in Fig.4.

The effect on *magnification, pincushion distortion,* and *resolution* as the distance is increased from the center of the photocathode toward its edge, is shown by the curves in Fig.5.

Subjecting the 6914 to intense incident-radiation levels may temporarily decrease the tube's sensitivity even though there is no voltage applied. The magnitude and duration of this decrease depend on the length of exposure. Permanent damage to the tube may result if it is exposed to radiant energy so great as to cause excessive heating of the photocathode.

Connections to the two terminals of the tube, indicated on the *Dimensional Outline,* should not be soldered to the terminals. They may be made by spring fingers engaging the rim or the straight side of each terminal.

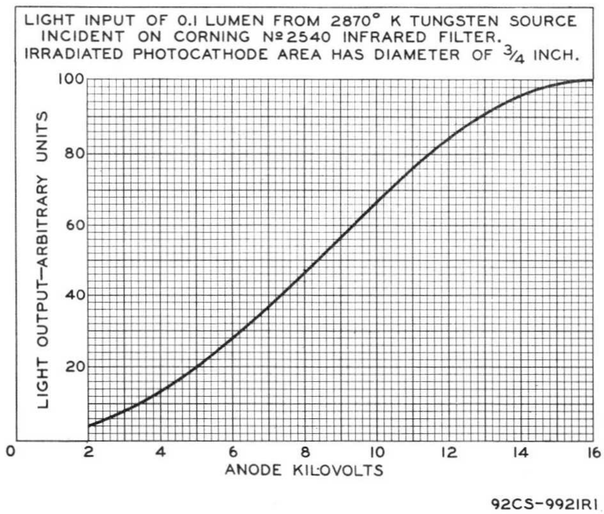


Fig.4 - Typical Characteristic of Type 6914.

Magnetic shielding of the 6914 is required to minimize the effects of extraneous fields on tube performance. It is to be noted that ac magnetic fields are particularly objectionable in that they seriously impair tube resolution. If an iron or steel case is used, care should be taken in its construction to insure that the case is completely demagnetized.

A mounting-arrangement guide is shown in Fig.6. It is intended to point out some of the areas that must be considered when designing a mounting arrangement. For example, to avoid corona effects, the metal parts on the end of the tube that are not at ground potential must be free of sharp edges. The tube is normally operated with the anode end at ground potential. However, either end of the tube may be grounded. The photocathode potential extends from the photocathode flange to the slight indentation in the tube envelope. Any mounting fixture at anode potential must, therefore, be insulated from this area of the bulb. The pressure holding the tube in compression may be as high as 40 pounds. However, only the minimum amount of uniformly distributed pressure necessary to hold the tube firmly in position for a given application should be employed.

The *dc supply voltage* for the 6914 may be obtained from a suitable high-voltage power-supply unit. Such units are offered commercially by several manufacturers listed in buyers' guides.

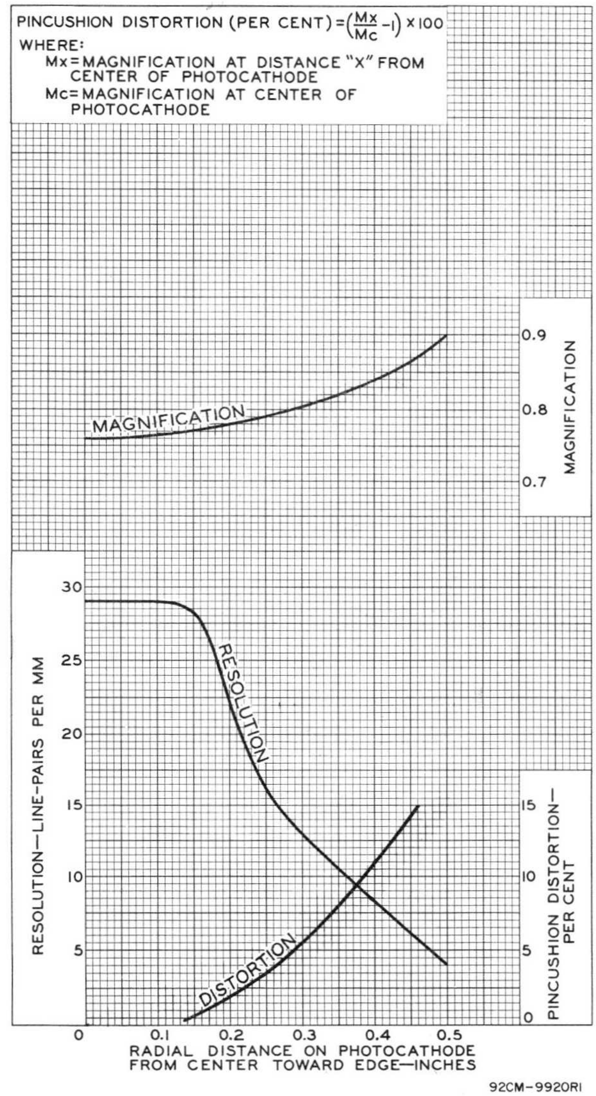


Fig.5 - Typical Characteristics of Type 6914.

The *high voltage at which the 6914 is operated may be very dangerous.* Great care should be taken in the design of apparatus to prevent the user from coming in contact with the high voltage. Precautions must include safeguards which eliminate all hazards to operating personnel. In the use of high-voltage tubes, such as the 6914, it should always be remembered that high voltage may appear at normally low-potential points in the circuit because of capacitor breakdown or incorrect circuit connections. Before any part of the circuit is touched, the voltage-supply switch should be turned off and both terminals of any capacitors grounded.

MOUNTING ARRANGEMENT GUIDE

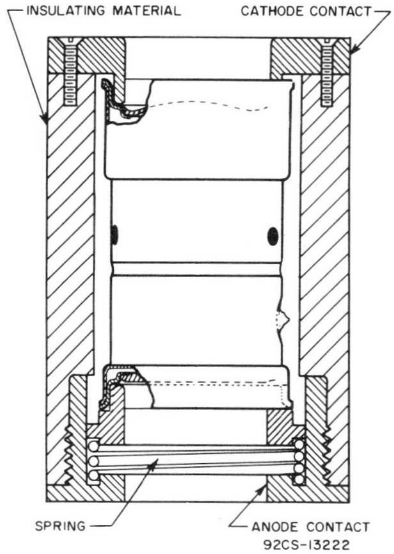
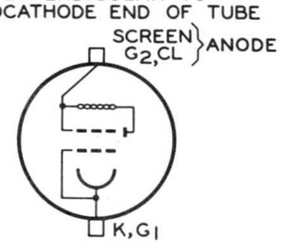


Fig. 6.

TERMINAL CONNECTIONS

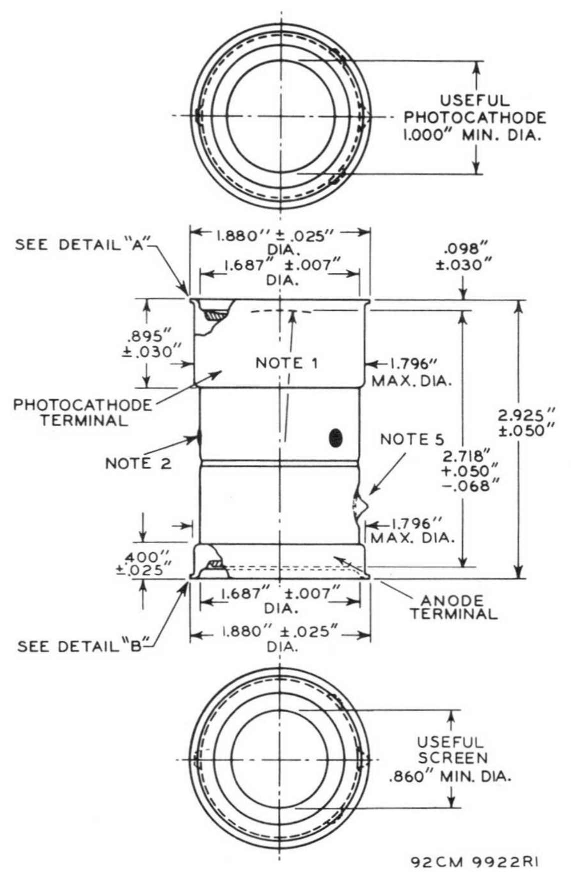
(See Dimensional Outline)

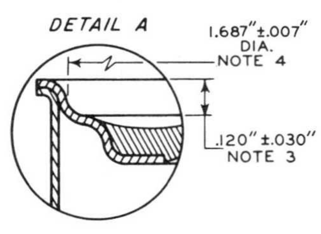
DIRECTION OF INCIDENT RADIATION: PERPENDICULAR TO PHOTOCATHODE END OF TUBE

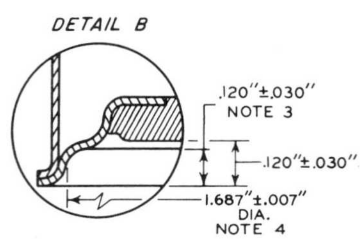


C_L: COLLECTOR
G_1: GRID No.1 (FOCUSING ELECTRODE)
G_2: GRID No.2 (FOCUSING & ACCELERATING ELECTRODE)
K: PHOTOCATHODE

DIMENSIONAL OUTLINE







NOTE 1: RADIUS OF CURVATURE OF FACEPLATE IS 2.38" ± 0.05". FACEPLATE THICKNESS AT CENTER IS 0.065" ± 0.004".

NOTE 2: THREE INSULATED LEAD TIPS WILL NOT EXTEND BEYOND MAXIMUM O.D. OF TUBE. LEADS ARE USED ONLY DURING TUBE MANUFACTURE.

NOTE 3: DEPTH IS MEASURED TO TANGENT OF THE TWO RADII.

NOTE 4: DIAMETER IS MEASURED TO TANGENT OF THE TWO RADII.

NOTE 5: THE EXHAUST TIP WILL NOT EXTEND BEYOND MAX. DIA. OF TUBE.

6914A

The 6914A is an image-converter tube like RCA-6914 except that it is processed and tested to meet the following special-performance test:

Max. Luminous Equivalent of Infrared Radiation for Threshold Visibility*. . . . . 4.1×10^{-11} lumen

* Radiation from a tungsten lamp operating at a color temperature of 2870° K is passed through a Corning No.2540 Infrared Filter and focused to a point on the photocathode. The resulting image on the fluorescent screen is viewed by a dark-adapted eye through a 10-power ocular. The amount of infrared radiation for threshold visibility is determined by reducing the incident radiation until the image on the screen can just be discerned. The luminous equivalent of this amount of infrared radiation is the value of luminous flux from a 2870° K source which produces a response equal to that produced by the infrared radiation when both are measured with a receiver having S-1 spectral response.

This bulletin also applies to RCA-4477 except that the minimum resolution rating of the 4477, at an anode voltage of 12000 volts dc, is 60 line-pairs per mm. *The 4477 is Unilaterally Interchangeable with the 6929.*

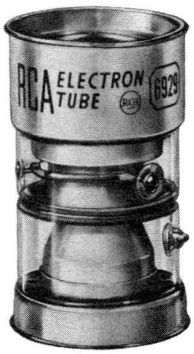
4477

RCA-6929

IMAGE-CONVERTER TUBE

Electrostatic Focus | **Monovoltage Type** | **2.335" Max. Length**
High Resolution | **S-1 Response** | **1.375" Max. Diameter**

RCA-6929 is a self-focusing image-converter tube useful in combination with suitable optical systems for viewing a scene irradiated with near-infrared radiation. It utilizes a semitransparent photocathode at one end on which the scene to be viewed is focused by means of an optical objective. Electrons from the image on the photocathode are electrostatically focused on the fluorescent screen at the other end of the tube by electron-optical methods to form a reduced image which can be viewed with an optical magnifier. The inverted image produced by the optical system on the photocathode is reinverted by the 6929 to give an observed image that is erect.



The 6929 is a monovoltage type, i.e., it operates with only a single voltage applied between its two terminals, and remains in focus with any applied voltage in the operating range from 8000 to 12000 volts. The voltage may be obtained from an unregulated rectified-power supply without a bleeder. Filtering can be provided by a single capacitor. Its value should be such as to provide a high ratio of average dc voltage to ripple voltage in order to obtain the highest average voltage, and hence the highest screen brightness, without exceeding the maximum voltage rating of the tube. Under typical viewing conditions, the value of operating power is less than 10 milliwatts at 12000 volts.

Features of the 6929 include a high ratio of light output to infrared-energy input, a minimum resolution of 25 line-pairs per millimeter at the center of the photocathode, and low pincushion distortion. These features, together with those of small size, low-power requirements, and self-focusing over a wide range of operating voltage, make the 6929 especially useful in portable equipment.

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Photocathode, Semitransparent:	
Shape	Convexo-Concave ←
Minimum useful diameter	0.750"
Fluorescent Screen:	
Shape	Plano-Plano ←
Minimum useful diameter	0.570"
Phosphor	P20, Aluminized
Fluorescence	Yellow-Green
Phosphorescence	Yellow-Green
Persistence	Medium-Short
Focusing Method (Self-focusing)	Electrostatic
Overall Length	2.285" ± 0.050"
Greatest Diameter	1.350" ± 0.025"
Terminals	See *Dimensional Outline*
Operating Position	Any
Weight (Approx.)	1.5 oz

Maximum Ratings, *Absolute-Maximum Values:*[a]

ANODE VOLTAGE:[b]		
Average (DC)	12500 max.	volts
Peak instantaneous	13000 max.	volts
AVERAGE PHOTOCATHODE CURRENT (Continuous operation)[c]	0.35 max.	μA
AMBIENT TEMPERATURE	75 max.	°C

Characteristics at Ambient Temperature of 22° C:

Anode Voltage (DC)[b]	12000	volts
Typical Paraxial Magnification Factor[d]	0.75	
Minimum Conversion Index[e]	10	
Minimum Resolution[f]	25	line-pairs per mm
Maximum Quotient[g] of Screen Background by Conversion Index	3.3×10^{-7}	lumen/cm²

[a] The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

← Indicates a change.

RADIO CORPORATION OF AMERICA
Electronic Components and Devices Harrison, N. J.

b Referred to photocathode.

c Averaged over any interval of 10 seconds maximum.

d Defined as the ratio of the linear size of the image on the fluorescent screen to the linear size of the image on the photocathode. The image on the photocathode consists of two parallel lines 0.08" long, each located 0.08" from the tube axis. Size of the image on the fluorescent screen is determined by measuring the spacing between the two parallel lines.

e Ratio of luminous flux from fluorescent screen to the product of the luminous flux incident on Corning No.2540 Infrared Filter (Melt No.1613, 2.61 mm thick), or equivalent, and the filter factor of 11.6 per cent. The light source is a tungsten-filament lamp operated at a color temperature of 2870° K.

f The resolution, both horizontally and vertically in a 0.15-inch-diameter circle centered on the photocathode, is determined with a pattern consisting of alternate black and white lines of equal width. Any two adjacent lines are designated as a "line-pair".

g The value of this quotient for any individual tube multiplied by the square of the magnification factor of the tube gives that value of the incident illumination from a 2870° K source required to produce an increase in screen brightness equal to the screen background.

OPERATING CONSIDERATIONS

Handling. The 6929 should be handled by the metal terminals. Fingerprints on the glass should be avoided since they cause leakage current, corona, and higher screen background. To minimize the possibility of leakage current and corona, the external surface of the glass side wall is coated with a transparent, non-hygroscopic film. This film should be cleaned only with a soft dry cloth.

The *spectral response* of the 6929 is shown by the curve of Fig.1.

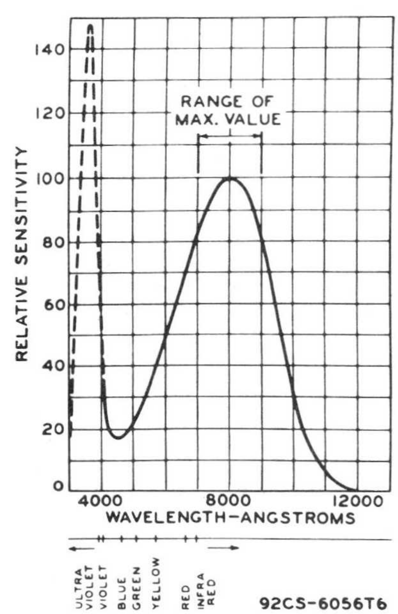


Fig.1 - Spectral Sensitivity Characteristic of Type 6929 which has S-1 Response. Curve is shown for Equal Values of Radiant Power at All Wavelengths.

The *fluorescent screen* employs the fine-grain phosphor P20 which fluoresces to produce a yellow-green luminescence. It has good visual qualities as well as high luminous efficiency. The spectral-energy emission characteristic of phosphor P20 is shown in Fig.2 and its persistence characteristic in Fig.3.

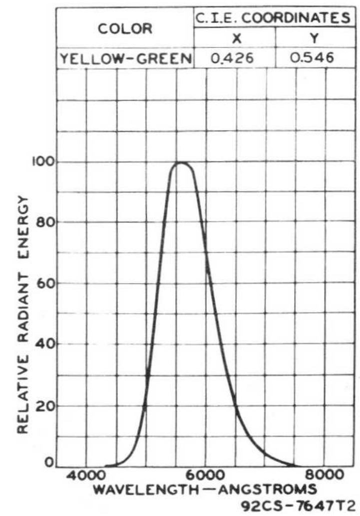


Fig.2 - Spectral-Energy Emission Characteristic of Phosphor P20.

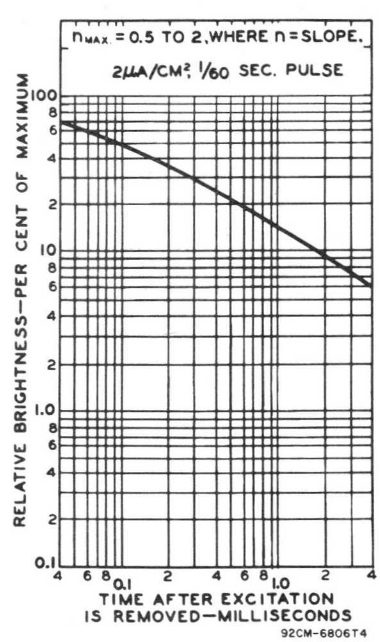


Fig.3 - Persistence Characteristic of Phosphor P20.

The effect on *magnification, pincushion distortion,* and *resolution* as the distance is increased from the center of the photocathode toward its edge is shown by the curves in Fig.4.

The *light output* from the 6929 as a function of anode voltage is given in Fig.5.

Subjecting the 6929 to intense incident-radiation levels may temporarily decrease the tube's sensitivity even though there is no voltage applied. The magnitude and duration of this decrease depend on the length of exposure. Permanent damage to the tube may result if it is exposed to radiant energy so great as to cause excessive heating of the photocathode.

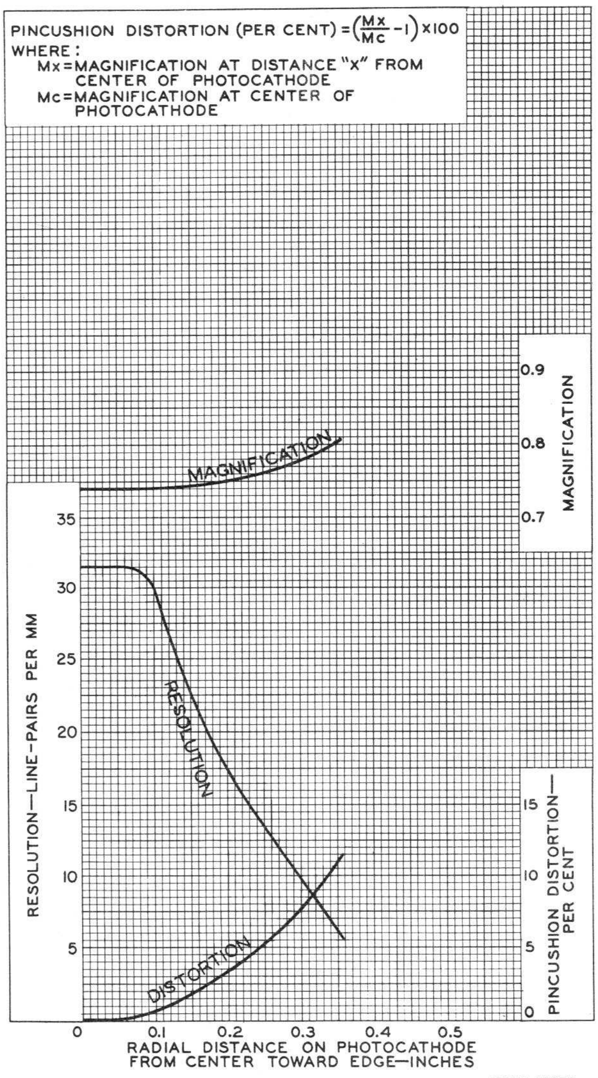


Fig.4 - Typical Characteristics of Type 6929.

Connections to the two terminals of the tube, indicated on the *Dimensional Outline,* should not be soldered to the terminals. They may be made by spring fingers engaging the rim or the straight side of each terminal.

Magnetic shielding of the 6929 is required to minimize the effects of extraneous fields on tube performance. It is to be noted that ac magnetic fields are particularly objectionable in that they seriously impair tube resolution. If an iron or steel case is used, care should be taken in its construction to insure that the case is completely demagnetized.

A mounting-arrangement guide is shown in Fig.6. It is intended to point out some of the areas that must be considered when designing a mounting arrangement For example, to avoid corona effects,

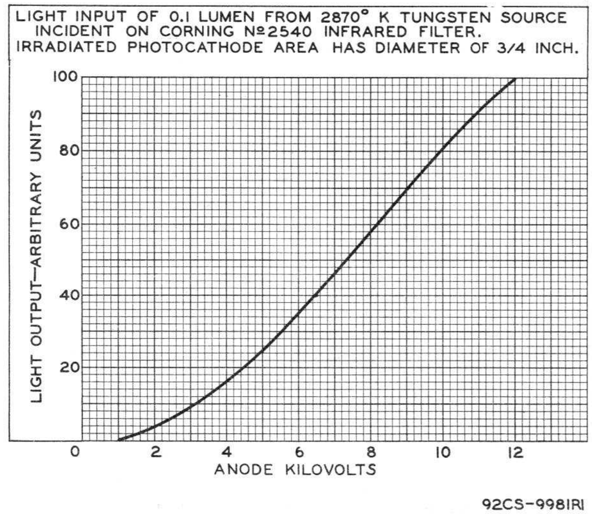


Fig.5 - Typical Characteristic of Type 6929.

the metal parts on the end of the tube that are not at ground potential must be free of sharp edges. The tube is normally operated with the anode end at ground potential. However, either end of the tube may be grounded. The photocathode potential extends from the photocathode flange to the slight indentation in the tube envelope. Any mounting fixture at anode potential must, therefore, be insulated from this area of the bulb. The pressure holding the tube in compression may be as high as 40 pounds. However, only the minimum amount of uniformly distributed pressure necessary to hold the tube firmly in position for a given application should be employed.

The *dc supply voltage* for the 6929 may be obtained from a high-voltage power supply unit. Units are offered commercially by several manufacturers listed in buyers' guides.

The *high voltage at which the 6929 is operated may be very dangerous.* Great care should be taken in the design of apparatus to prevent the user from coming in contact with the high voltage. Precautions must include safeguards which eliminate all hazards to operating personnel. In the use of high-voltage tubes, such as the 6929, it should always be remembered that high voltage may appear at normally low-potential points in the circuit because of capacitor breakdown or incorrect circuit connections. Before any part of the circuit is touched, the voltage-supply switch should be turned off and both terminals of any capacitors grounded.

MOUNTING ARRANGEMENT GUIDE

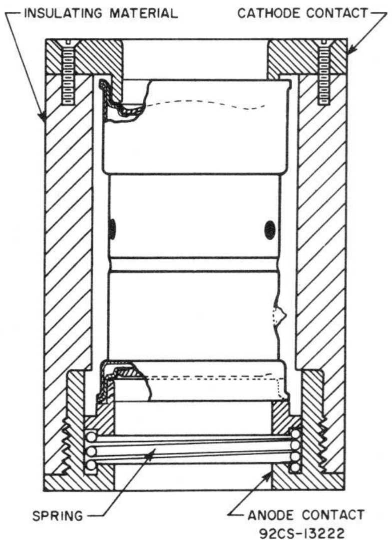
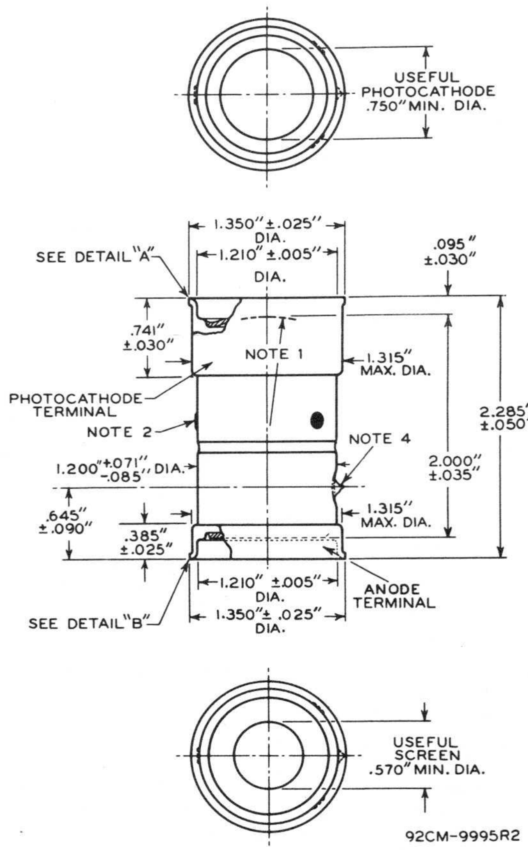


Fig.6.

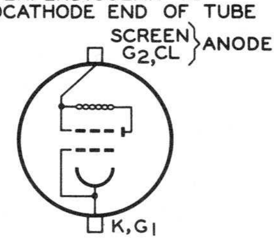
DIMENSIONAL OUTLINE



TERMINAL CONNECTIONS

(See Dimensional Outline)

DIRECTION OF INCIDENT RADIATION:
PERPENDICULAR TO
PHOTOCATHODE END OF TUBE



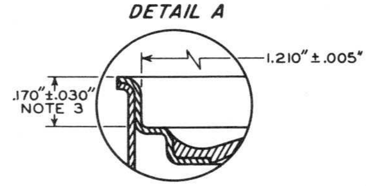
CL: COLLECTOR

G_1: GRID No.1 (FOCUSING ELECTRODE)

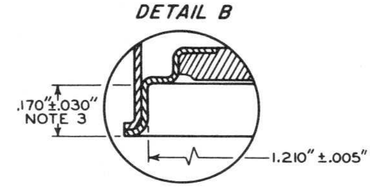
G_2: GRID No.2 (FOCUSING & ACCELERATING ELECTRODE)

K: PHOTOCATHODE

DETAIL A



DETAIL B



NOTE 1: RADIUS OF CURVATURE OF FACEPLATE IS 1.230" ± 0.005"; FACEPLATE THICKNESS AT CENTER IS 0.060" ± 0.004".

NOTE 2: THREE INSULATED LEAD TIPS WILL NOT EXTEND BEYOND MAXIMUM O.D. OF TUBE. LEADS ARE USED ONLY DURING TUBE MANUFACTURE.

NOTE 3: DEPTH IS MEASURED TO TANGENT OF THE TWO RADII.

NOTE 4: TIP WILL NOT EXTEND BEYOND MAXIMUM O.D. OF TUBE.

T.P.D.

This bulletin is to be used in conjunction with publication RCA Photo-conductive Cells—ICE-230.

6957

PHOTOCONDUCTIVE CELL

Cadmium-Sulfide, Head-On Type
S-15 Response

Actual Size

RCA-6957 is a sturdy, head-on type of cadmium-sulfide photoconductive cell intended for use in street-lighting control and in a variety of industrial light-operated control applications. Featuring high illumination sensitivity, the 6957 is capable of direct relay operation without the use of an amplifier. The spectral response of the 6957 covers the approximate range from 3300 to 7400 angstroms. Maximum response occurs at about 5800 angstroms.

DATA

General:

Spectral Response		S-15
Wavelength of Maximum Response	5800 ± 500 angstroms	
Sensitive Surface, Including Metallic Electrodes:		
Shape		Rectangular
Length (Minimum)	0.650	in.
Width (Minimum)	0.540	in.
Area (Minimum)	0.35	sq. in.
Maximum Overall Length	2-7/32	in.
Maximum Seated Length	1-11/16	in.
Seated Length to Plane of Sensitive Surface	1 ± 3/32	in.
Maximum Diameter	1-9/32	in.
Bulb		T9
Base . . . Intermediate-Shell Octal 5-Pin (JEDEC No. B5-10)		
Operating Position		Any
Weight (Approx.)	0.9	oz

Maximum Ratings, *Absolute-Maximum Values:*[a]

VOLTAGE BETWEEN TERMINALS (DC or Peak AC)	250 max.	volts
POWER DISSIPATION —		
Sensitive surface fully illuminated:		
Continuous service	0.5 max.	watt
Demand service[b]	0.8 max.	watt
Sensitive surface partially illuminated:		
Continuous service	1.4 max.	watt/sq. in.
Demand service[b]	2.3 max.	watt/sq. in.
PHOTOCURRENT	50 max.	ma
AMBIENT TEMPERATURE RANGE	-75 to +60	°C

Characteristics:

Under conditions with dc voltage of 50 volts between terminals and ambient temperature of 25° C

	Min.	Median	Max.	
Sensitivity:				
Illumination[cd]	2	4	8	ma/fc
Photocurrent[ce]	–	–	20	μa
Rise	See *Fig.2 of publication ICE-230*			
Decay	See *Fig.3 of publication ICE-230*			

[a] The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[b] The demand rating may be utilized twice every 24 hours for a period of 20 minutes each time provided the interval between demand periods is not less than 4 hours.

[c] This characteristic is determined after the 6957 has been exposed to 50 to 100 footcandle illumination (white fluorescent light) for a period of 4 to 5 hours.

[d] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. Incident illumination is 1 footcandle.

[e] Measured 10 seconds after removal of incident illumination of 1 footcandle.

DEFINITION

Illumination Sensitivity. The quotient of output current by the incident illumination, at constant electrode voltages.

OPERATING CONSIDERATIONS

Photocurrent as a function of voltage between terminals at different values of cell illumination, and cell resistance (dc) as a function of cell illumination are shown in Fig. 1 and Fig. 2, respectively.

The *base pins* of the 6957 fit the octal 5-contact socket. The socket should be made of high-grade, low-leakage material and should be installed so that incident light falls on the face end of the cell.

A *typical circuit* for the 6957 is shown in Fig. 3. In this circuit, the relay is normally energized when the light is incident on the cell.

When the light is interrupted or when the light level decreases to a predetermined value, the relay operates. The potentiometer is employed to permit adjustment of the photocurrent. The circuit of Fig.3 operates with light levels as low as 1 footcandle.

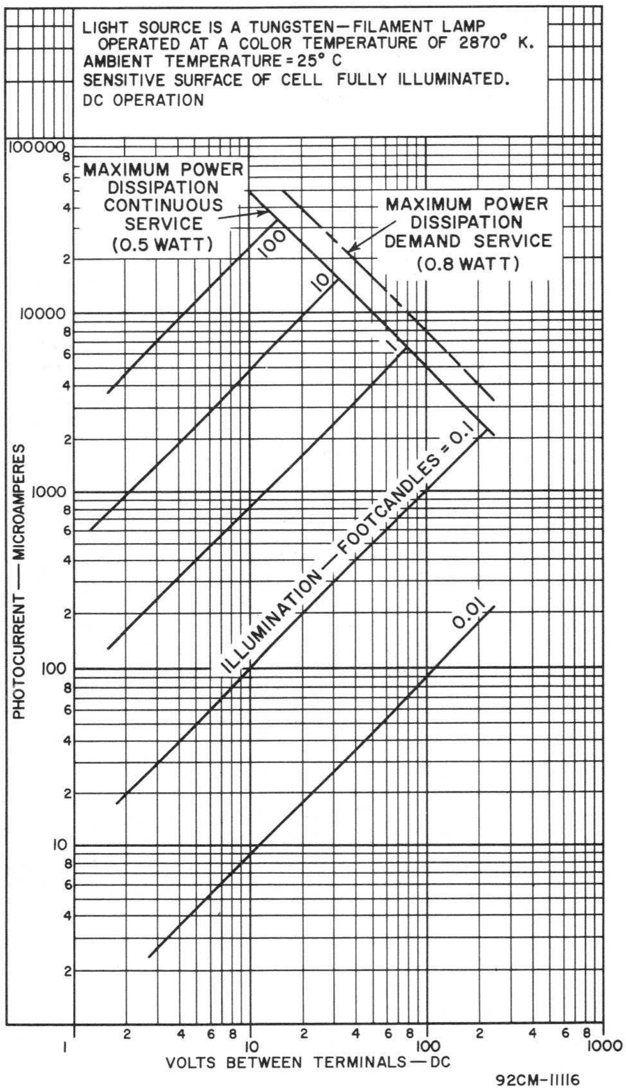


Fig. 1 - Average Characteristics of Type 6957.

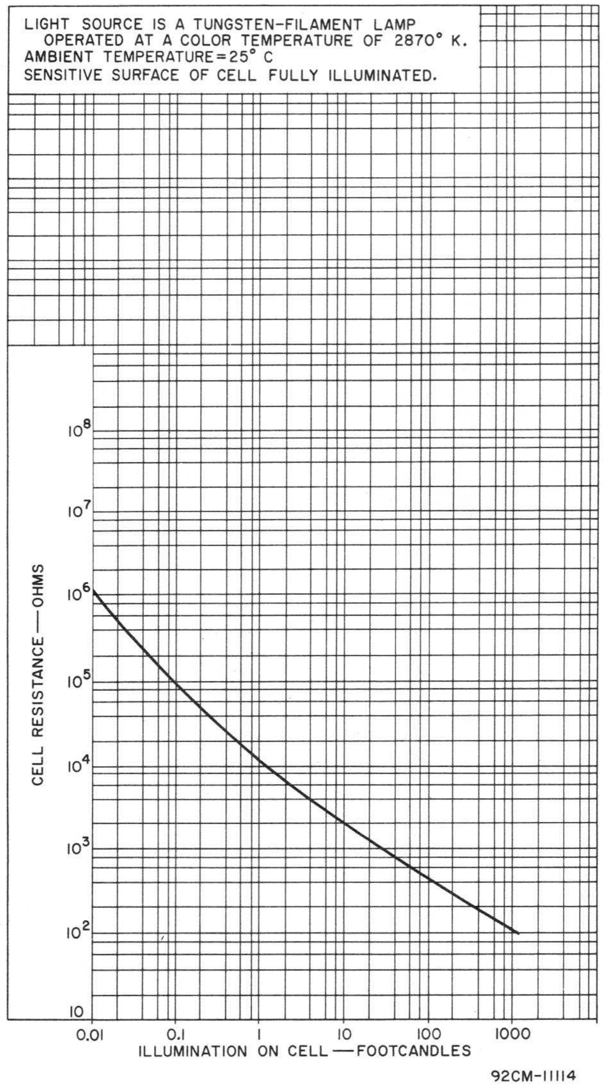
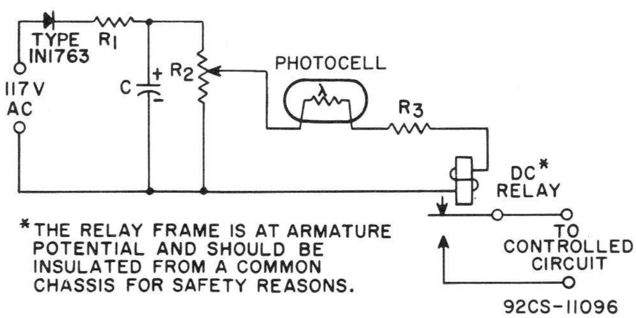


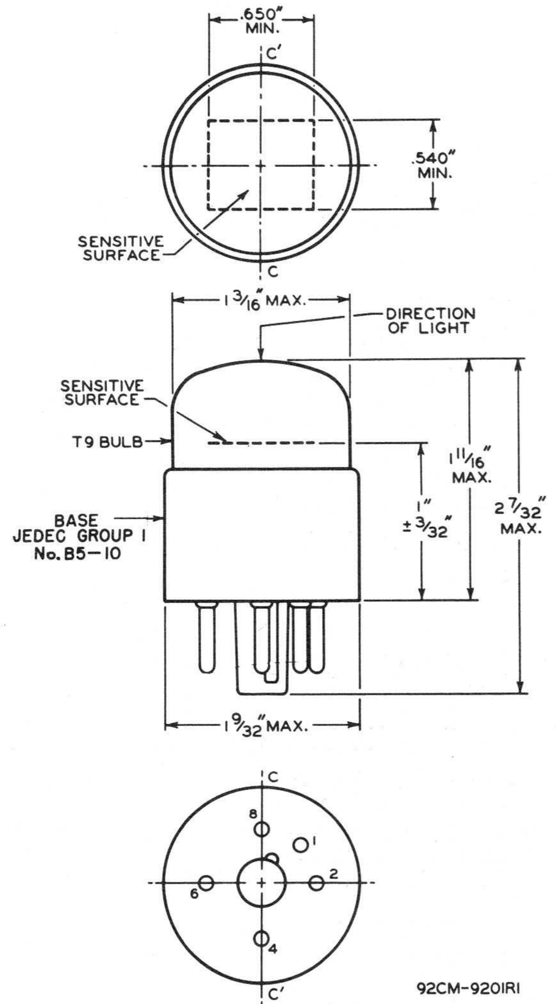
Fig. 2 - Average Cell Resistance (DC) of Type 6957.



C : 8 μf, electrolytic, 250 volts (dc working)
R_1: 5.6 ohms, 1 watt
R_2: 25000-ohm potentiometer, 2 watts
R_3: 10000 ohms, 1 watt
DC Relay: Sigma, Type 11F-9000 G/SIL, or equivalent. 9000 ohms, 2.4 ma operating current.

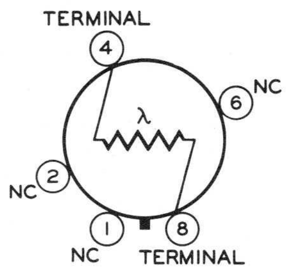
Fig. 3 - Typical High-Sensitivity Circuit for Type 6957.

DIMENSIONAL OUTLINE



PLANE THROUGH MINOR AXIS (CC') OF SENSITIVE SURFACE AND CELL AXIS MAY VARY FROM PLANE THROUGH THE CELL AXIS AND PINS No. 4 AND 8 BY ANGULAR TOLERANCE (MEASURED ABOUT THE CELL AXIS) OF ± 10°.

BASING DIAGRAM
Bottom View



DIRECTION OF LIGHT: INTO END OF BULB

8HV

PIN 1: NO CONNECTION
PIN 2: NO CONNECTION
PIN 4: TERMINAL
PIN 6: NO CONNECTION
PIN 8: TERMINAL

RCA

PHOTOCONDUCTIVE CELLS
Cadmium-Sulfide Types
S-15 Response

Information shown on these pages is to be used in conjunction with the attached technical bulletin only.

RCA cadmium-sulfide photoconductive cells are designed for use in a variety of light-operated control applications. Cells of this type feature:

- high to extremely high illumination sensitivity
- hermetic sealing to permit operation under conditions of high humidity
- operation without regard to polarity of applied voltage

Spectral response for these cells covers the approximate range from 3300 to 7400 angstroms as shown in Fig. 1. Maximum response occurs at about

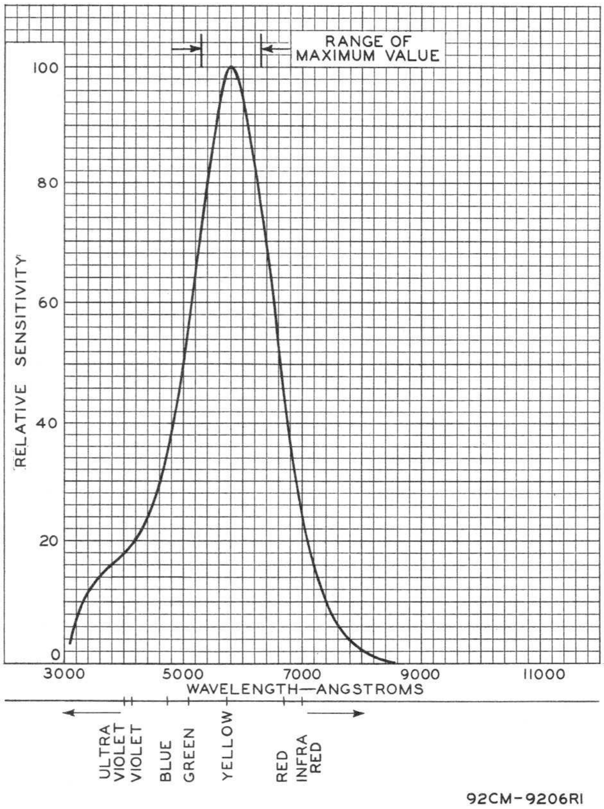


Fig. 1 - Tentative Spectral Sensitivity Characteristic for Cadmium-Sulfide Cell which has S-15 Response. Curve is shown for Equal Values of Radiant Flux at all Wavelengths.

5800 angstroms. Highest sensitivity is therefore obtained from yellow-red light. The photosensitive cadmium-sulfide is located between metallic electrodes.

Rise time for cell photocurrent to reach a steady value after excitation is applied is a function of illumination as shown in Fig. 2.

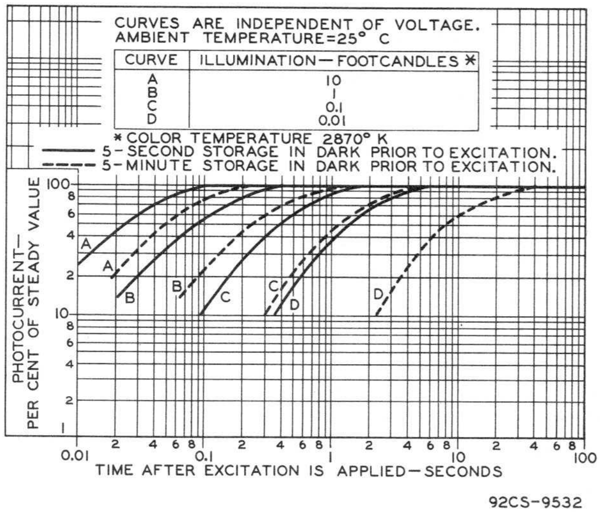


Fig. 2 - Typical Rise Characteristics of Cadmium-Sulfide Cell.

Photocurrent decay after removal of excitation is a function of time and illumination as shown in Fig. 3.

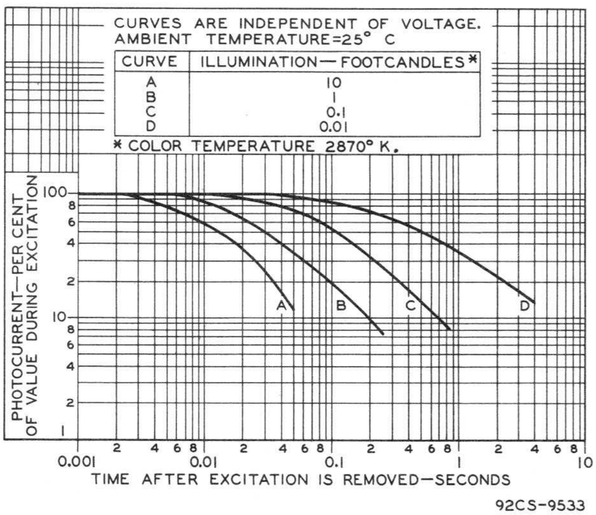


Fig. 3 - Typical Decay Characteristics of Cadmium-Sulfide Cell.

Cell Response to pulsed light is shown in Fig.4.

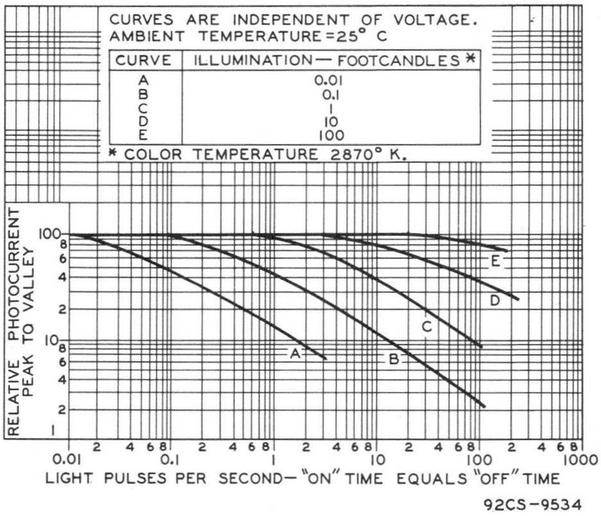


Fig.4 - Response Characteristics of Cadmium-Sulfide Cell to Pulsed Light.

The effect of ambient temperature on cell sensitivity is shown in Fig.5.

The angle of view of the cell may be narrowed by use of a hood of the desired length placed in front of the sensitive surface.

If the source of radiation is some distance from the cell, the use of a light-collecting lens system may be desirable to utilize more effectively the available radiation. However, when such a system is used the radiation should not be focused onto such a small area that localized overheating of the sensitive surface may result with consequent adverse affects on its characteristics. Exposure of these cells to radiation (even without voltage applied) so intense as to cause excessive heating of the cells may permanently damage them.

For a given illumination, the output current will have its highest value when the incident illumination is normal (angle of incidence is 0^{o}) to the face of the cell. For greater angles of incidence, the output current decreases. The decrease depends upon several factors including the angle of incidence of the illumination, the amount of illumination, and the area of sensitive surface illuminated.

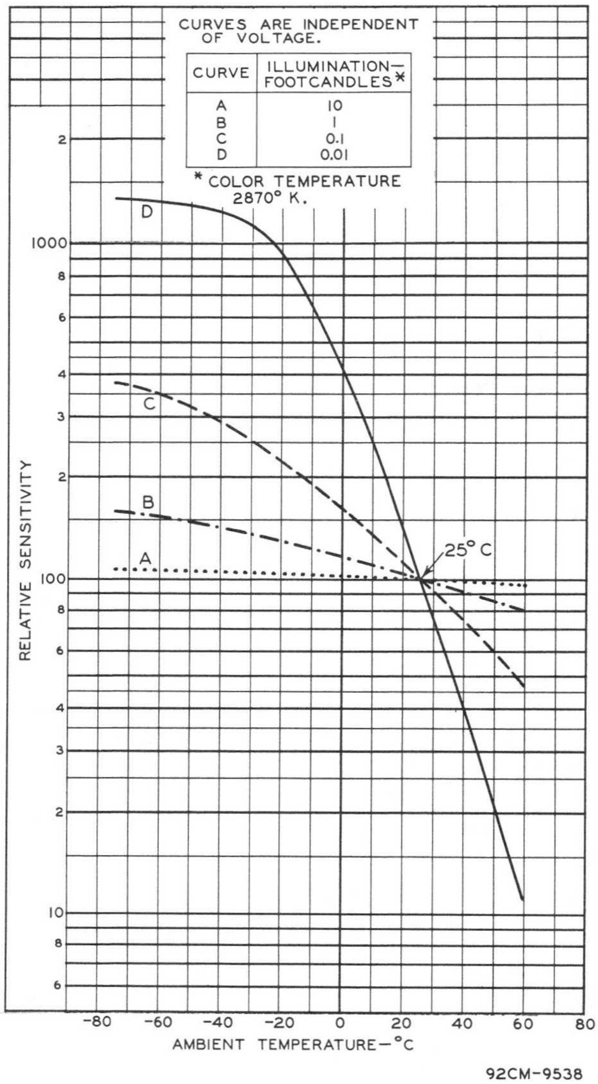


Fig.5 - Typical Characteristics of Cadmium-Sulfide Cell.

7008

MAGNETRON

Integral Magnet
Forced-Air Cooled

Servo Tunable
8500 - 9600 Mc
For Pulsed-Oscillator Service

220 Kw Peak
Power Output

TENTATIVE DATA

RCA-7008 is a tunable magnetron intended for service as a pulsed oscillator at frequencies between 8500 and 9600 megacycles per second. It offers the advantages of providing an adjustable frequency for radar equipment and of permitting servo tuning of such equipment while it is in operation.

The 7008 operates with high efficiency and with full power ratings at pulse durations up to 2.75 microseconds. It has a maximum peak input power rating of 630 kilowatts, a maximum peak anode voltage rating of 23 kilovolts, and a maximum peak anode current rating of 27.5 amperes. When operated at a peak anode current of 27.5 amperes, corresponding to a peak anode voltage of about 22 kilovolts, the 7008 is capable of giving a peak power output of approximately 220 kilowatts.

The design of the 7008 features excellent stability at a high rate of rise of anode voltage and provides good spectrum shape, low pushing figure, good frequency stabilization, low thermal drift during warm-up and after tuning, and a relatively uniform power output over its frequency band. In addition, the 7008 design includes a servo-drive shaft with associated digital indicator. This shaft operates with low torque and has low backlash over the rated temperature range of the tube. The 7008 employs an axial cathode having good structural rigidity; a getter to maintain a high vacuum and minimize any tendency toward arcing after a period of storage; and an output waveguide which can be coupled to a standard JAN RG-51/U waveguide by means of a modified JAN UG-52A/U choke flange. A double-helical heater minimizes mechanical resonance of the heater and reduces hum modulation at the power-line frequency.

The output waveguide flange and the mounting flange are designed to permit use of pressure seals. The heater-cathode stem of the 7008 will operate without electrical breakdown at atmospheric pressures as low as 600 mm of mercury.

The 7008 is electrically similar to tunable type 6865-A as well as to the fixed-frequency type 4J50 and has a similar mounting arrangement.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	13.75 ± 10%	volts
Current at 13.75 volts	3.15	amperes
Starting Current. . .The maximum instantaneous starting current must never exceed 12 amperes even momentarily		
Minimum Cathode Heating Time	2.5	minutes
Frequency	8500 - 9600	Mc
Maximum Frequency Pulling at VSWR of 1.5	15	Mc

Mechanical:

Operating Position . . . . Any

Dimensions . . . . See *Dimensional Outline*

Air Flow:

Through Ducts--An air stream should be directed through each of the cooling ducts provided on the tube. Adequate flow should be provided so that the temperature of the anode block does not exceed 150° C. Typical air-flow requirements are shown in Fig.1.

To Heater-Cathode Terminal--Adequate flow should be provided to maintain the temperature of the heater-cathode terminal below 165° C.

Waveguide Output Flange . . . . . Mates with Modified JAN UG-52A/U Flange

Servo-Drive Shaft with Associated Calibrated Indicator:

Revolutions (Approx.) to cover full range of 8500 to 9600 Mc	160	
Maximum Torque (Absolute) at tuning-range stops	192	oz-in.
Typical Torque between -55° and +150° C (approx.)	6	oz-in.
Weight (Approx.)	13	lbs

PULSED OSCILLATOR SERVICE

Maximum and Minimum Ratings, *Absolute Values:*

For Duty Cycle up to 0.0011 max.

PEAK ANODE VOLTAGE	23 max.	kv
PEAK ANODE CURRENT	27.5 max.	amp
PEAK POWER INPUT●	630 max.	kw
AVERAGE POWER INPUT	0.630 max.	kw
PULSE DURATION	2.75 max.	µsec
RATE OF RISE OF VOLTAGE PULSE:		
For pulse duration of 1 µsec or less	225 max. / 70 min.	kv/µsec / kv/µsec
For pulse duration greater than 1 µsec	200 max. / 70 min.	kv/µsec / kv/µsec
ANODE-BLOCK TEMPERATURE	150 max.	°C
HEATER-CATHODE TERMINAL TEMPERATURE	165 max.	°C
LOAD VOLTAGE STANDING WAVE RATIO	1.5 max.	

Typical Operation# with Load Voltage Standing Wave Ratio Equal to or Less than 1.05, except as noted:

With Duty Cycle of 0.001

Heater Voltage	See Text		
Peak Anode Voltage	22	22	kv
Peak Anode Current	27.5	27.5	amp

Pulse Repetition Rate . . .	400	4000	cps
Pulse Duration.	2.5	0.25	μsec
RF Bandwidth with worst phasing of 1.5 VSWR	0.5	5	Mc
Side Lobes with worst phasing of 1.5 VSWR	8	10	db
Pulling Figure at VSWR of 1.5.	10	10	Mc
Pushing Figure.	0.2	0.2	Mc/amp
Thermal Factor for any 30° range of anode-block temperature between -55° C and 150° C.	0.2	0.2	Mc/°C
Servo-Drive-Shaft Torque. . .	6	6	oz-in.
Frequency Deviation due to Tuning Backlash	8	8	Mc
Peak Power Output (Approx.) .	220	220	kw

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Heater Current.	1	2.8	3.5	amp
Peak Anode Voltage.	2	20	23	kv
Peak Power Output	3	180	-	kw
Pulses Missing from Total . .	4,5	-	0.25	%

Note 1: With 13.75 volts ac or dc on heater.

Note 2: With peak anode current of 27.5 amperes. For heater voltage, see page 5.

Note 3: With peak anode current of 27.5 amperes corresponding to a peak anode voltage in the order of 22 kv, anode-block temperature of 115° C approx., pulse duration of 2.5 microseconds, and maximum load voltage standing wave ratio equal to or less than 1.05. For heater voltage, see page 5.

Note 4: Pulses are considered to be missing if the energy level at the operating frequency is less than 70% of the normal value.

Note 5: With peak anode current of 27.5 amperes corresponding to a peak anode voltage in the order of 22 kv, anode-block temperature of 115° C approx., pulse duration of 0.25 microsecond, load voltage standing wave ratio of 1.5 adjusted in phase to produce maximum instability. For heater voltage, see page 5.

• For atmospheric pressure greater than 600 millimeters of mercury in the vicinity of the heater-cathode stem. Operation at pressures lower than 600 millimeters of mercury may result in arc-over across the stem with consequent damage to the tube. The waveguide must always be pressurized to a minimum of 15 psi absolute to prevent arcing, especially when there is a mismatched load. Arcing in the waveguide due to lack of pressure can damage the tube.

It is essential that the input circuit be designed so that if arcing occurs the energy per pulse delivered to the tube cannot greatly exceed the normal energy per pulse. To satisfy this requirement, it is recommended that pulsers of the discharging-network type be used.

OPERATING CONSIDERATIONS

The *maximum ratings* shown in the tabulated data are limiting values above which the serviceability of the 7008 may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value below each absolute rating by an amount such that the absolute values will never be exceeded under any usual condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

The *high voltage at which the 7008 is operated is very dangerous.* Great care should be taken in the design of apparatus to prevent the operator from coming in contact with the high voltage. Precautions include the enclosing of high-potential terminals and the use of interlocking switches to break the primary circuit of the power supply when access to the equipment is required.

Magnetic-Field Precautions. In general, magnetrons with integral magnets, such as the 7008, should be stored so as to maintain a minimum distance of 6 inches between tubes. If this precaution is not followed, excessive interaction between the magnetic fields of adjacent magnets may occur with consequent decrease in the strength of the magnetic fields. In addition, it is important to maintain a minimum distance of 2 inches between the magnet and any magnetic

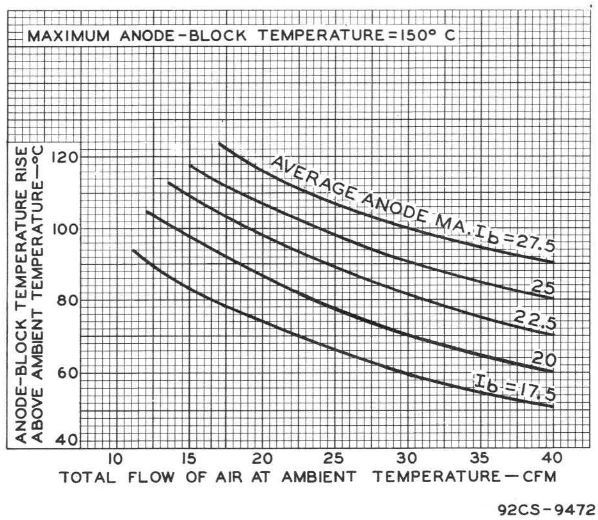


Fig.1 - Typical Cooling Requirements for Anode Block of Type 7008 With Duct Arrangement Described in Text.

materials and to use non-ferrous tools during installation. Failure to observe this latter precaution may subject the magnet to sharp mechanical shocks which may result in demagnetization of the magnet. Furthermore, precautions should be observed to insure that the magnetic field of the 7008 does not affect nearby instruments and tubes.

In the *handling* of the 7008, exercise care to prevent rough treatment which might distort the metal structure and cooling ducts. Any such distortion may result in loss of vacuum or impairment of the electrical characteristics. *The tube should never be held by the heater-cathode stem* because undue strain on the cathode assembly will weaken the structure and will result in permanent damage to the tube.

Care should be taken to prevent any foreign matter or corrosive substances from entering the recessed cathode terminal or from lodging in the opening in the waveguide output flange. As a

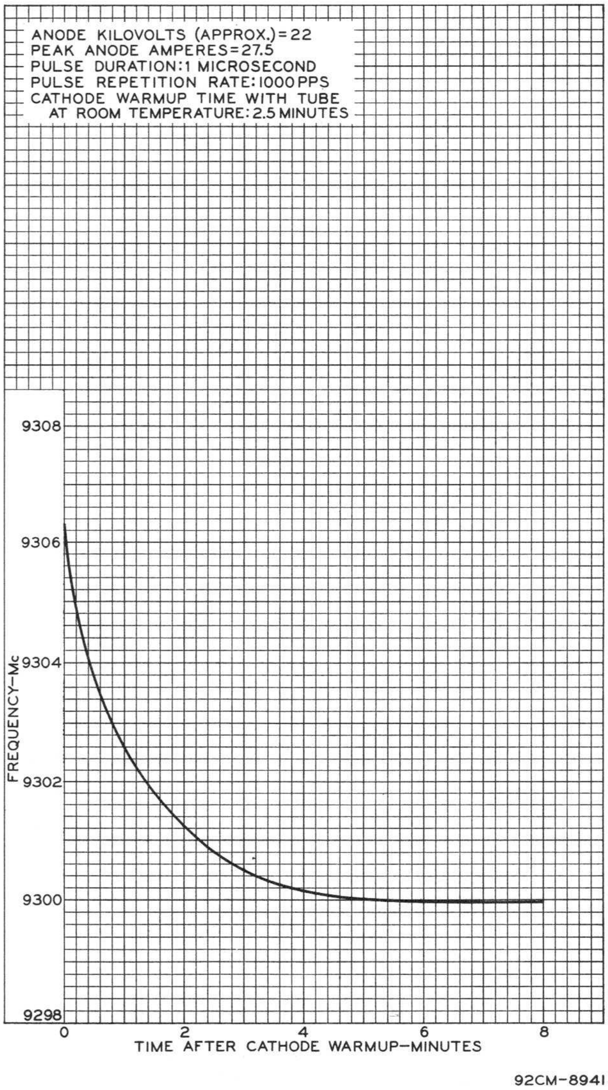


Fig.2 - Typical Stabilization Characteristic of Type 7008.

safeguard, it is recommended that the protective dust cover over this flange be left on until the tube is ready to be mounted in the equipment.

The approximate weight of the 7008 is: packed for shipment, 19-1/2 pounds; and unpacked, 13 pounds.

Mounting of the 7008 should be accomplished by means of the mounting flange which may be positioned to operate the tube in any orientation. This flange is made to permit use of the 7008 in applications requiring a pressure seal. Care should be taken by the equipment designer to insure that the tube is mounted on a surface having adequate flatness so as to avoid possible distortion of the mounting flange when it is bolted to the mounting surface. Captive 1/4" - 20 bolts are provided at the corners of the mounting flange for mounting the magnetron. These four mounting bolts are held in position during shipment of the 7008 by plastic sleeving which also serves to protect the bolt threads.

Fastening the JAN RG-51/U waveguide to the waveguide output flange of the tube is accomplished in the following manner. A JAN UG-52A/U choke flange or equivalent should be modified by drilling out the screw threads from the four mounting holes in the choke flange using a No.15 drill. This operation will permit four size 8-32 bolts inserted through the flange mounting holes, to engage the threaded waveguide output flange

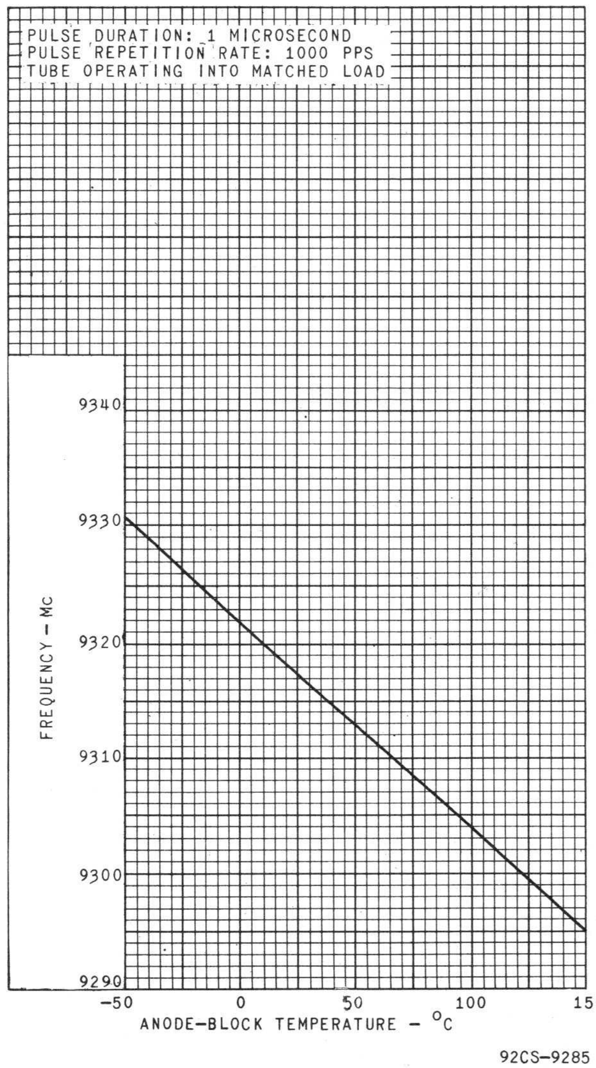


Fig.3 - Typical Thermal-Factor Characteristic of Type 7008.

of the tube. It is recommended that the choke flange be sufficiently tight to avoid arcing and other contact effects. Before the choke flange is fastened to the waveguide output flange of the tube, the user should make certain that the waveguide window is entirely free of dust to prevent possible arcing with consequent damage to the tube.

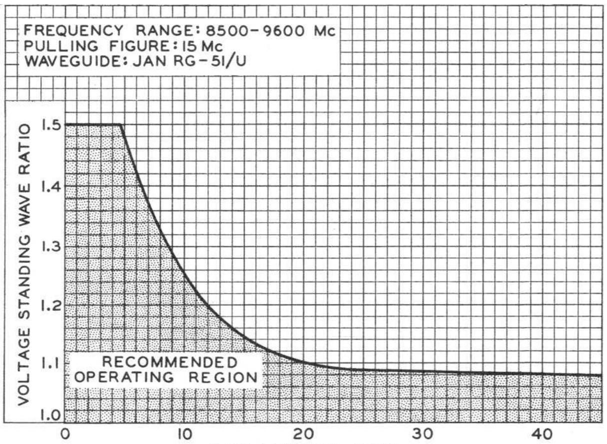


Fig.4 - Effect of Length of Transmission Line between Output Flange and Load on Allowable Voltage Standing Wave Ratio.

A conduit should be attached to each of the inlet-air duct flanges provided on the tube. The conduits should be made of flexible, non-magnetic material. Rubber hose or stainless-steel hose is suitable. Fastening of the conduits requires two non-magnetic 6-32 screws at each duct. Adequate flow of cooling air should be provided through the ducts to maintain the temperature of the anode block below 150° C under any condition of operation. Failure to provide adequate cooling will impair tube life. Fig.1 shows typical cooling requirements for the anode block of the 7008. Cooling of the heater-cathode terminal may be required under some conditions to maintain the temperature of this terminal below 165° C.

A mechanical drive may be connected to the drive shaft of the 7008 by using a flexible coupling drilled for a 3/16-inch diameter shaft and held in place by a setscrew. When the magnetron is installed in radar equipment which has a frequency index dependent upon rotation of the drive shaft, both the index and the 7008 tuner indicator should be adjusted to the same frequency before the drive-coupling is connected to the drive shaft.

The *heater terminal and the heater-cathode terminal require the use of a connector with flexible leads* such as the Ucinite* No.115364 with built-in capacitor, or equivalent. Unless flexible leads are used, the heater and heater-cathode seals may be damaged.

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* Manufactured by Ucinite Div. of United-Carr Fastener Corp., Newtonville 60, Mass.

When a new tube is first placed in service, it is recommended that the pulse voltage be raised gradually to minimize possible arcing within the tube. If there is evidence of arcing, operate the tube with reduced input for a period of from 15 to 30 minutes after which arcing usually ceases.

A *heater starter* should be used to raise the voltage gradually and to limit the instantaneous starting current through the heater when the circuit is first closed. The starter may be either a system of time-delay relays cutting resistance out of the circuit, a high-reactance heater transformer, or a simple rheostat. Regardless of the

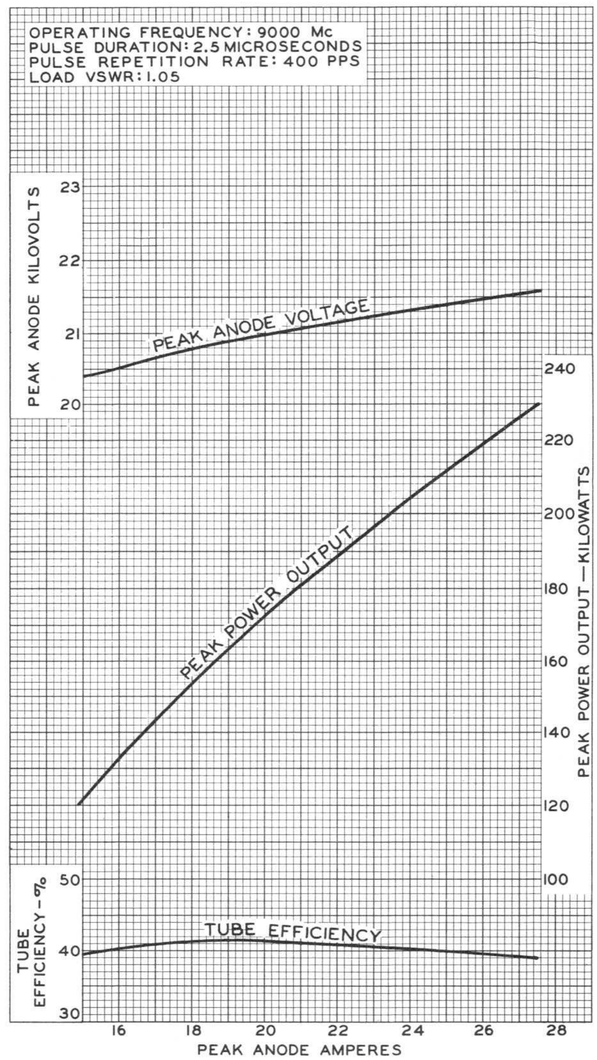


Fig.5 - Typical Performance Curves for Type 7008.

method of control, it is important that the maximum instantaneous starting current never exceed, even momentarily, a value of 12 amperes. Exceeding this value may damage the heater.

After the heater voltage is raised to its rated value of 13.75 volts, allow the cathode to warm up for at least 2-1/2 minutes to make sure that the cathode reaches operating temperature. When the cathode has reached full operating temperature, high-voltage pulses, negative with respect to anode (ground), can be applied to the heater-cathode terminal. As soon as the 7008 begins to oscillate, the heater voltage (E_f) should be reduced in accordance with the following formula, depending on the average power input (P_i) to the tube:

$$P_i \text{ up to 450 watts:} \quad E_f = 13.75 \left(1 - \frac{P_i}{450}\right) \text{ volts}$$

$$P_i \text{ greater than 450 watts:} \quad E_f = 0 \text{ volts}$$

When the 7008 is oscillating, the cathode is subjected to considerable electron bombardment which raises the temperature of the cathode. The magnitude of such heating is a function of the total dissipation and must be compensated by reduction of heater voltage in order to prevent overheating of the cathode. Failure to start the tube at rated heater voltage and to reduce the heater voltage as soon as oscillation starts may adversely affect tube life.

The heater should be protected against input pulse power by placing a suitable capacitor in shunt with the heater leads as near the heater-cathode stem as possible in order to limit the magnitude of the transient voltages which may develop across the heater. This capacitor may be incorporated in the design of the connector

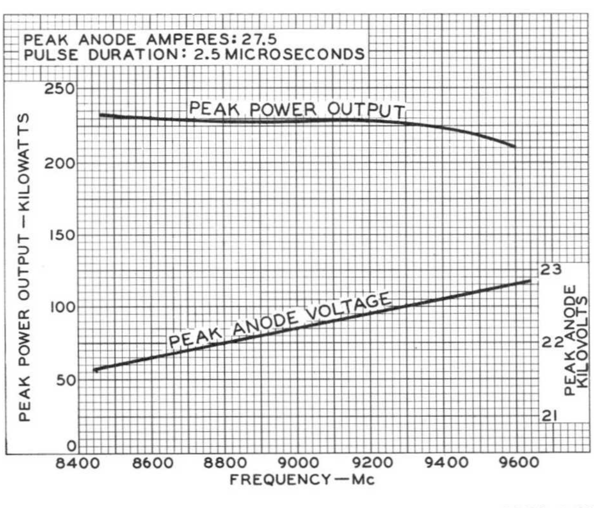


Fig.6 - Typical Performance Curves for Type 7008.

for the heater terminal and heater-cathode terminal.

Stabilization. After the high-voltage pulses are applied, the temperature of the tube rises until a condition of thermal equilibrium is reached. During this period, the physical dimensions of the tube change and thus cause the resonant frequency of the anode structure to

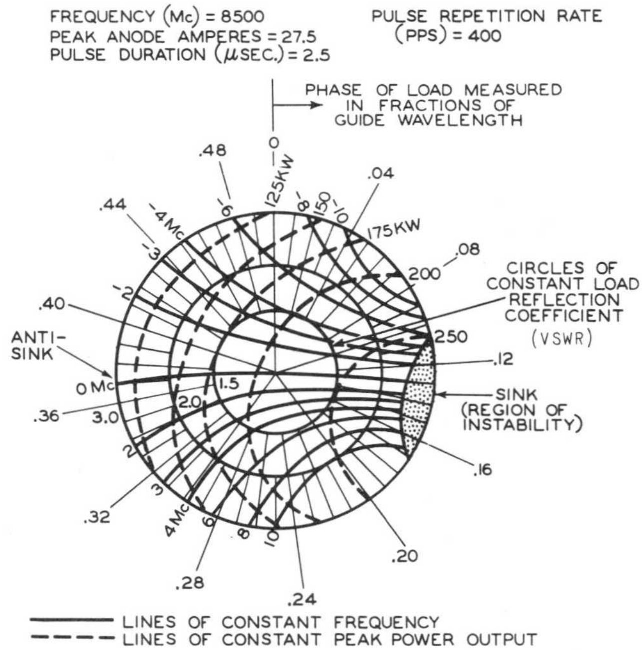


Fig.7 - Rieke Diagram for Type 7008.

change. The time required for stabilization is shown in Fig.2. Fig.3 shows the change of frequency which results from anode temperature changes.

For *standby operation*, during which the high-voltage pulses are not applied to the tube, the heater voltage should be restored to 13.75 volts.

The *anode-circuit return* should be made to the *heater-cathode terminal*. If the anode-circuit return is made to the heater terminal, all of the anode current will flow through the heater and may cause heater burnout.

The *leads between the pulse generator and the magnetron* should be kept as short as possible because the reactance of long leads may distort the pulse waveform.

The *shape of the voltage pulse* as supplied to the tube by the driving circuit should conform to the values indicated in the tabulated data. It is essential that the total voltage variation across the top of a single pulse be less than five per cent of the smooth peak value to insure good spectrum shape. Poor pulse shape can cause excessive frequency modulation and tube instability. Modulation of the mean pulse voltage from pulse to pulse should be held to a minimum. The trailing edge of the voltage pulse should decrease rapidly to produce the best frequency spectrum. High positive peaks in the ripple, or backswing following the voltage pulse, if excessive, may cause instability or noise.

The 7008 should be operated with a *well-matched load.* Tube life and reliability will be increased if the VSWR of the load is kept near

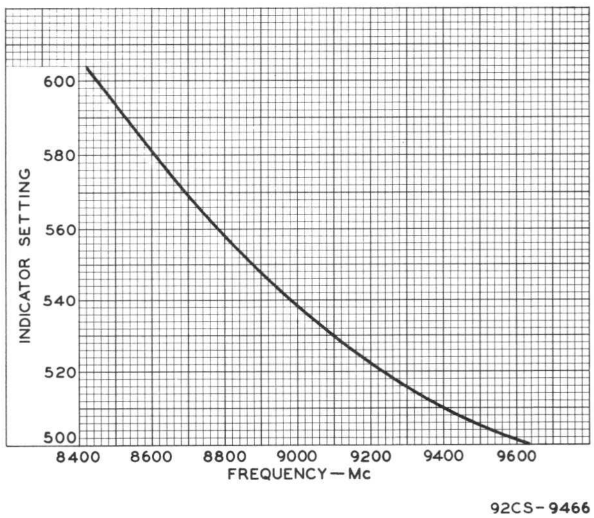


Fig.8 - Representative Tuning Characteristic of Type 7008.

unity, either by the use of a suitably matched load or by using a ferrite load isolator. Under no circumstances should the tube be operated with a VSWR greater than 1.5.

The *use of an electrically long transmission line* between the output of a magnetron and its load can cause frequency instability with resulting deterioration of spectrum. Such unsatisfactory operation has been called "long-line effect". The extent to which "long-line effect" is exhibited depends on three factors: the pulling figure or degree of coupling of the load to the oscillator, the length of line between an impedance discontinuity and the tube, and the degree of impedance discontinuity. Fig.4 indicates the effect of length of transmission line between output flange and load on the allowable voltage standing wave ratio.

For *optimum performance,* the pulse-generating equipment, pulse line, pulse transformer, the magnetron, and the associated circuitry should all be considered as a unit and be designed to work together.

Typical performance curves for the 7008 are given in Figs.5 and 6. Fig.5 shows the peak power output, tube efficiency, and peak anode voltage as functions of peak anode current with the tube operating into a matched load. Fig.6 shows peak power output and peak anode voltage as functions of operating frequency.

In Fig.7 is shown the Rieke diagram for the 7008. This diagram indicates pulling figure and power variations as functions of load VSWR magnitude and phase. The 7008 should always be operated within the 1.5 VSWR circle.

The *frequency of the 7008 may be preset* by turning the drive shaft until the setting of the indicator is reached corresponding to the desired frequency. For precise tuning adjustment, the final indicator setting should be approached using a counterclockwise direction of rotation which is the direction of increasing frequency. A representative tuning curve for the 7008 is shown in Fig.8.

Revolutions of the servo-drive shaft are not indicated directly by the indicator. Approximately 160 revolutions of the drive shaft are required to tune through the 8500 to 9600 Mc range. A tuning rate of 200 megacycles per second can be achieved. Typical servo-drive-shaft torque is 6 ounce-inches throughout the temperature range of -55^{o} to 150^{o} C. Mechanical stops are provided at each end of the tuning range. Torque applied to these stops and the starting torque must not exceed 192 ounce-inches (1 foot-pound) including inertial effects.

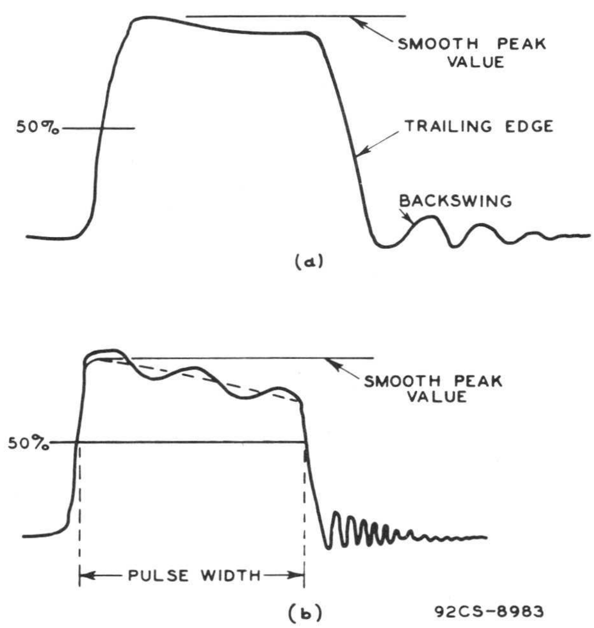


Fig.9 - Waveforms Showing Smooth Peak Value, Trailing Edge, Backswing, and Pulse Width.

Our engineers are ready to assist you in circuit applications of the RCA-7008. For further information, write to Commercial Engineering, RCA, Harrison, New Jersey, giving complete details as to the proposed service.

DEFINITIONS

Smooth Peak Value. The maximum value of a smooth curve drawn through the average of the fluctuation over the top of a voltage or current pulse, as illustrated in Fig.9.

Pulse Width. The time interval between the two points of the current pulse at which the current is 50 per cent of the smooth peak value.

Rate of Rise of Voltage Pulse. The steepest slope of the voltage pulse leading edge above 50 per cent of the smooth peak value.

Measurement of the rate of rise of voltage should be made using a capacitance divider with an input capacitance not exceeding 6 $\mu\mu f$. An oscilloscope of sufficient bandpass, such as the Tektronix 517 or equivalent, should be used.

REFERENCES

J. B. Fisk, H. D. Hagstrom, and L. A. Hartman, *"The Magnetron as Generator of Centimeter Waves"*, The Bell System Technical Journal, Vol.XXV, No.2, pp.167-348, April, 1946.

George B. Collins (Editor) *"Microwave Magnetrons"*, McGraw-Hill Book Company, Inc., 1948.

Joseph F. Hull, Gabriel Novick, and Richard Cordray, *"How Long-Line Effect Impairs Tunable Radar"*, Electronics, Vol.27, No.2, p.168, February, 1954.

NOTES FOR DIMENSIONAL OUTLINE

For Dimensional Outline, see page 8

Reference plane A is defined as the plane through that portion of the mounting flange designated as annular surface D.

Reference plane B is defined as the plane which is perpendicular to plane A and passes through the exact centers of mounting-flange holes No.2 & No.3 which have the specified bolts inserted through them.

Reference plane C is defined as the plane which is perpendicular to plane A & plane B and passes through the exact center of mounting-flange holes No.3 & No.4 which have the specified bolts inserted through them.

NOTE 1: Surface E of the waveguide output flange, and the entire mounting flange are made so that they may be used to provide a hermetic seal.

NOTE 2: The axis of the heater-cathode terminal will be within the confines of a cylinder whose radius is 3/64" and whose axis is perpendicular to reference plane A at the specified location.

NOTE 3: All points on mounting flange will lie within 0.015" above or below reference plane A.

NOTE 4: The limits include annular as well as lateral deviations.

NOTE 5: These dimensions define extremities of the 0.169" internal diameter of the cylindrical heater terminal.

NOTE 6: These dimensions define extremities of the 0.540" internal diameter of the cylindrical heater-cathode terminal.

NOTE 7: No part of the connector device for the heater and heater-cathode terminals should bear against the underside of this lip.

NOTE 8: The heater terminal and the heater-cathode terminal are concentric with 0.010".

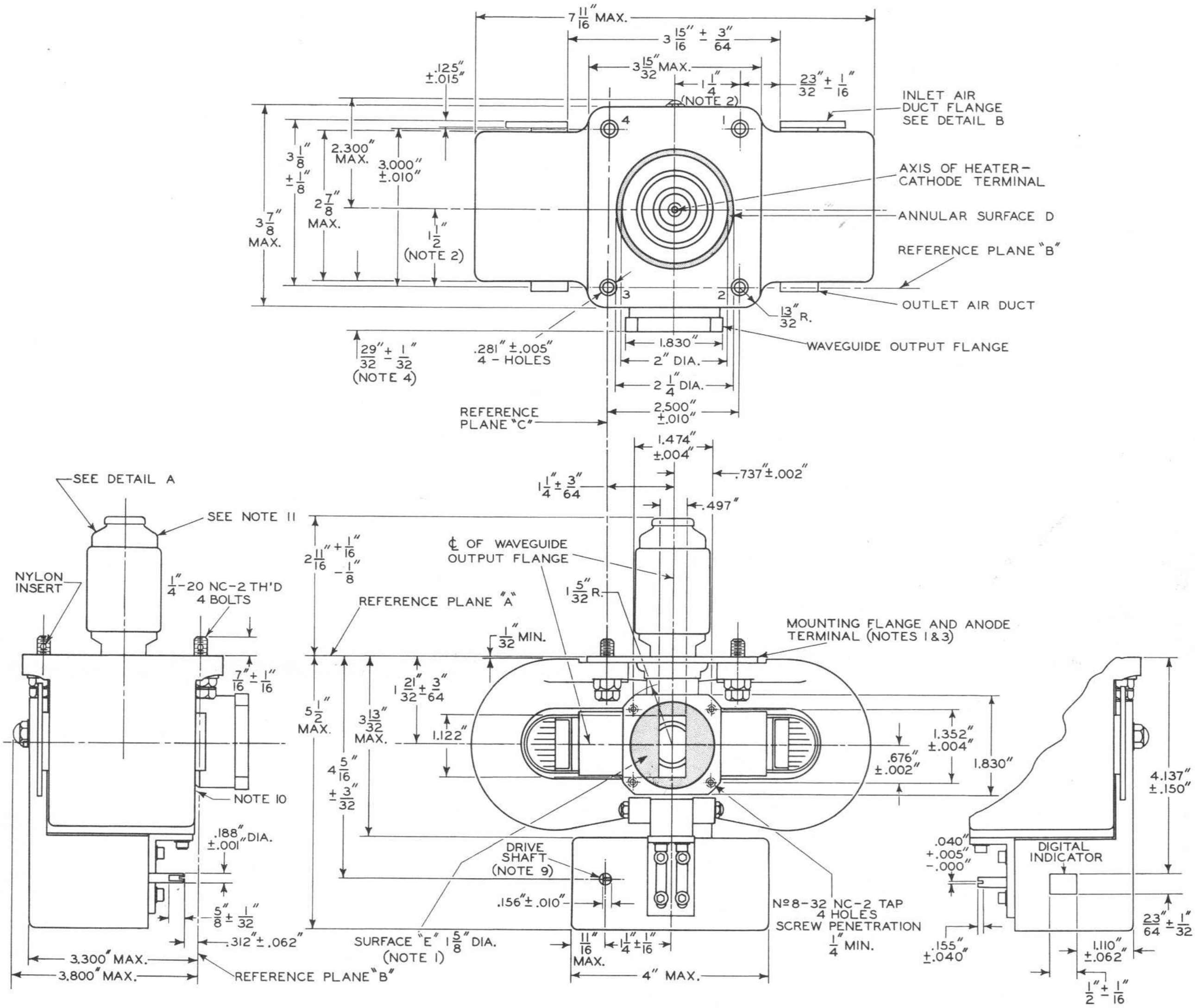
NOTE 9: Clockwise rotation of drive shaft decreases frequency.

NOTE 10: Anode temperature measured at junction of waveguide and anode block.

NOTE 11: Temperature of heater-cathode terminal measured here.

DIMENSIONAL OUTLINE

For Notes, see page 7



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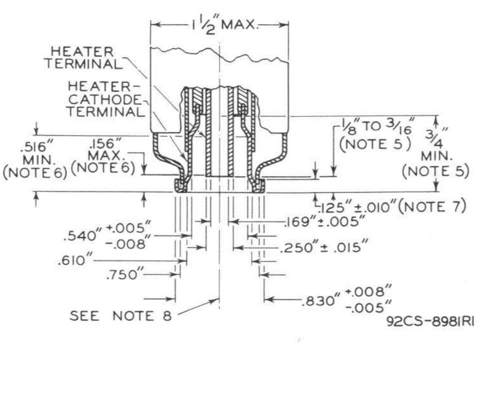
DETAIL A



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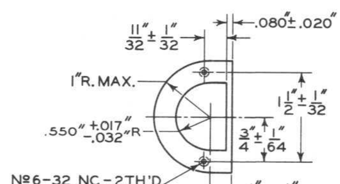
DETAIL B



92CS-9486

T.P.D.

7094

BEAM POWER TUBE

High Power Gain
Sturdy Structure

500 Watts CW Input (ICAS) Up to 60 Mc
335 Watts CW Input (ICAS) at 175 Mc
Forced-Air Cooled at Max. Ratings

5" Max. Length
2.56" Max. Diameter

RCA-7094 is a high-perveance beam power tube with high power gain. It is useful in fixed and mobile equipment as an rf power amplifier and oscillator, as well as an af power amplifier and modulator.

The 7094 has a maximum plate dissipation of 125 watts under ICAS conditions in modulator service and in cw service. In the latter service it can be operated with full input to 60 Mc and with reduced input to 175 Mc.

Because of its high power gain, the 7094 can be operated with relatively low plate voltage to give large power output with small driving power.

Small and compact for its power-output capability, the 7094 has a rugged button-stem construction with short internal leads, internal shield connected to grid No.2 within the tube, triple base-pin connections for grid No.2 to permit effective rf grounding, plate structure with large radiating fins for effective cooling, and ceramic mount supports to provide additional sturdiness to the electrode structure. The plate lead is brought out of bulb to a rigid terminal opposite the base to facilitate separation of input and output circuits.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC).	6.3 ± 10%	volts
Current at 6.3 volts.	2.85	amperes
Mu-Factor, Grid No.2 to Grid No.1 for plate volts = 300, grid-No.2 volts = 300, and plate ma = 150. .	7	
Direct Interelectrode Capacitances (With no external shield Approx.):		
Grid No.1 to plate.	0.6	μμf
Grid No.1 to grid No.2 & internal shield	11	μμf
Grid No.1 to cathode and heater.	8.5	μμf
Grid No.2 & internal shield to plate.	9.5	μμf
Grid No.2 & internal shield to cathode and heater	2.0	μμf
Plate to cathode and heater . .	0.2	μμf

Mechanical:

Operating Position. Any
Maximum Overall Length. . . . . 5"
Seated Length . . . . 4.44" ± 0.08"
Maximum Diameter. . . . . 2.56"
Base. . . . . .Jumbo-Button Septar 7-Pin (JEDEC No.E7-46)
Socket. . Johnson Nos. 122-247 or 122-248*, or equivalent
Weight (Approx.). . . . . 6 oz
Bulb Temperature (At hottest point) . . . . 250 max. °C
Cooling: Free circulation of air around the tube is required. Under operating conditions at maximum ratings, some forced-air cooling will be required from a small fan to prevent exceeding the specified maximum bulb temperature.

AF POWER AMPLIFIER & MODULATOR — Class AB1[a]

Maximum Ratings, *Absolute-Maximum Values:*[d]

	CCS[b]	*ICAS*[c]	
DC PLATE VOLTAGE. . . .	1500 max.	2000 max.	volts
DC GRID-No.2 VOLTAGE. .	400 max.	400 max.	volts
MAX.-SIGNAL DC PLATE CURRENT[e].	350 max.	350 max.	ma
MAX.-SIGNAL PLATE INPUT[e].	300 max.	400 max.	watts
MAX. SIGNAL GRID-No.2 INPUT[e].	20 max.	20 max.	watts
PLATE DISSIPATION[e]. . .	100 max.	125 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode.	135 max.	135 max.	volts
Heater positive with respect to cathode.	135 max.	135 max.	volts

Typical Operation:

Values are for 2 tubes

DC Plate Voltage. . . .	1500	2000	volts
DC Grid-No.2 Voltage[f] .	400	400	volts
DC Grid-No.1 Voltage[g] .	-65	-65	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage . .	120	120	volts
Zero-Signal DC Plate Current	60	60	ma
Max.-Signal DC Plate Current	400	400	ma
Max.-Signal DC Grid-No.2 Current.	70	70	ma
Effective Load Resistance (Plate to plate).	8700	12000	ohms
Max.-Signal Driving power (Approx.) . . .	0	0	watts
Max.-Signal Power Output (Approx.). . .	410	560	watts

* E.F. Johnson Company, Waseca, Minnesota. Note that the separate shield rings furnished with these sockets should be discarded since these rings do not accomodate the 7094.

LINEAR RF POWER AMPLIFIER — Class AB1[a]
Single-Sideband Suppressed-Carrier Service

	CCS[b]	ICAS[c]	
Maximum Ratings, *Absolute-Maximum Values up to 60 Mc:*[d]			
DC PLATE VOLTAGE. . . .	1500 max.	2000 max.	volts
DC GRID-No.2 VOLTAGE. .	400 max.	400 max.	volts
MAX.-SIGNAL DC PLATE CURRENT	350 max.	350 max.	ma
MAX.-SIGNAL PLATE INPUT	300 max.	400 max.	watts
MAX.-SIGNAL GRID-No.2 INPUT	20 max.	20 max.	watts
PLATE DISSIPATION . . .	100 max.	125 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode.	135 max.	135 max.	volts
Heater positive with respect to cathode.	135 max.	135 max.	volts

Typical Operation for "Single-Tone Modulation" at 60 Mc:[h]

DC Plate Voltage. . . .	1500	2000	volts
DC Grid-No.2 Voltage[f] .	400	400	volts
DC Grid-No.1 Voltage[g] .	-65	-65	volts
Max.-Signal Peak RF Grid-No.1 Voltage . .	60	60	volts
Zero-Signal DC Plate Current	30	30	ma
Max.-Signal DC Plate Current	200	200	ma
Max.-Signal Grid-No.2 Current	35	35	ma
Effective RF Load Resistance.	4350	6000	ohms
Max.-Signal Driver Power Output (Approx.)	4	4	watts
Output-Circuit Efficiency (Approx.). .	90	90	%
Max.-Signal Useful Power Output (Approx.)	185[j]	250[j]	watts

LINEAR RF POWER AMPLIFIER — Class B
Single-Sideband Suppressed-Carrier Service

High-Mu Triode Connection — Grids No.1 and No.2 Connected Together

	CCS[b]	ICAS[c]	
Maximum Ratings, *Absolute-Maximum Values up to 60 Mc:*[d]			
DC PLATE VOLTAGE. . . .	1500 max.	2000 max.	volts
MAX. SIGNAL DC PLATE CURRENT	350 max.	350 max.	ma
MAX.-SIGNAL DC GRID CURRENT (Combined Grids No.1 & No.2). .	200 max.	200 max.	ma
MAX.-SIGNAL PLATE INPUT	300 max.	400 max.	watts
PLATE DISSIPATION . . .	100 max.	125 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode.	135 max.	135 max.	volts
Heater positive with respect to cathode.	135 max.	135 max.	volts

Typical Operation in Cathode-Drive Circuit at 60 Mc with "Single-Tone Modulation":[n]

DC Plate-to-Grids No.1 & No.2 Voltage. . . .	1350	1750	volts
DC Grids No.1 & No.2 Voltage	0	0	volts
Zero-Signal DC Plate Current	30	44	ma
Effective RF Load Resistance.	3800	5100	ohms
Max.-Signal DC Plate Current	200	200	ma
Max.-Signal DC Grid Current (Combined Grids No.1 & No.2). .	140	140	ma
Max.-Signal Peak RF Cathode-to-Grids-No.1 & No.2 Voltage. . . .	50	50	volts
Max.-Signal Driver Power Output (Approx.)[k].	15	15	watts
Output-Circuit Efficiency (Approx.). .	90	90	%
Max.-Signal Useful Power Output (Approx.)	160[j]	210[j]	watts

PLATE-MODULATED RF POWER AMPLIFIER— Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

	CCS[b]	ICAS[c]	
Maximum Ratings, *Absolute-Maximum Values:*[d]			
For max. plate voltage and max. plate input above 60 Mc, see Rating Chart I			
DC PLATE VOLTAGE. . . .	1000 max.	1200 max.	volts
DC GRID No.2 VOLTAGE. .	400 max.	400 max.	volts
DC GRID-No.1 VOLTAGE. .	-300 max.	-300 max.	volts
DC PLATE CURRENT. . . .	280 max.	280 max.	ma
DC GRID-No.1 CURRENT. .	25 max.	30 max.	ma
PLATE INPUT	250 max.	335 max.	watts
GRID-No.2 INPUT	13.5 max.	13.5 max.	watts
PLATE DISSIPATION . . .	67 max.	83 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode.	135 max.	135 max.	volts
Heater positive with respect to cathode.	135 max.	135 max.	volts

Typical Operation at 60 Mc:

DC Plate Voltage. . . .	1000	1200	volts
DC Grid-No.2 Voltage[m] .	400	400	volts
DC Grid-No.1 Voltage[n] .	-130	-130	volts
Peak RF Grid-No.1 Voltage	145	150	volts
DC Plate Current. . . .	250	275	ma
DC Grid-No.2 Current. .	20	20	ma
DC Grid-No.1 Current (Approx.)	5	5	ma
Driver Power Output (Approx.)[pk]	5	5	watts
Output-Circuit Efficiency (Approx.). .	90	90	%
Useful Power Output (Approx.)	165[j]	240[j]	watts

Typical Operation at 175 Mc:

DC Plate Voltage. . . .	700	820	volts
DC Grid-No.2 Voltage[m] .	400	400	volts
DC Grid-No.1 Voltage[n] .	-130	-130	volts
DC Plate Current. . . .	250	275	ma
DC Grid-No.2 Current. .	8	8	ma
DC Grid-No.1 Current (Approx.)	6	6	ma
Driver Power Output (Approx.)[k].	8	8	watts
Output-Circuit Efficiency (Approx.). .	85	85	%
Useful Power Output (Approx.)	105[j]	135[j]	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance[q]	30000 max.	ohms

RF POWER AMPLIFIER & OSC. — Class C Telegraphy[r] and RF POWER AMPLIFIER—Class C FM Telephony

Maximum Ratings, *Absolute-Maximum Values:*[d]

For max. plate voltage and max. plate input above 60 Mc, see Rating Chart II

	CCS[b]	*ICAS*[c]	
DC PLATE VOLTAGE. . .	1250 max.	1500 max.	volts
DC GRID-No.2 VOLTAGE. .	400 max.	400 max.	volts
DC GRID-No.1 VOLTAGE. .	-300 max.	-300 max.	volts
DC PLATE CURRENT. . . .	340 max.	340 max.	ma
DC GRID-No.1 CURRENT. .	25 max.	30 max.	ma
PLATE INPUT	375 max.	500 max.	watts
GRID-No.2 INPUT	20 max.	20 max.	watts
PLATE DISSIPATION . . .	100 max.	125 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode.	135 max.	135 max.	volts
Heater positive with respect to cathode.	135 max.	135 max.	volts

Typical Operation at 60 Mc:

DC Plate Voltage. . . .	1000	1250	1500	volts
DC Grid-No.2 Voltage[s] .	400	400	400	volts
DC Grid-No.1 Voltage[t] .	-100	-100	-100	volts
Peak RF Grid-No.1 Voltage	125	120	125	volts
DC Plate Current. . . .	330	300	330	ma
DC Grid-No.2 Current. .	20	18	20	ma
DC Grid-No.1 Current (Approx.)	5	5	5	ma
Driver Power Output (Approx.)[pk]	4	4	4	watts
Output-Circuit Efficiency (Approx.). .	90	90	90	%
Useful Power Output (Approx.)	215	255	340	watts

Typical Operation at 175 Mc:

DC Plate Voltage. . . .	665	875	1000	volts
DC Grid-No.2 Voltage[s] .	400	400	400	volts
DC Grid-No.1 Voltage[t] .	-100	-100	-100	volts
DC Plate Current. . . .	335	300	335	ma
DC Grid-No.2 Current. .	8	7	8	ma
DC Grid-No.1 Current (Approx.)	5	5	5	ma
Driver Power Output (Approx.)[k].	8	7	8	watts
Output-Circuit Efficiency (Approx.). .	85	85	85	%
Useful Power Output (Approx.)	130	170	215	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance[q]	30000 max.	ohms

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Heater Current.	1	2.55	3.15	amp
Mu-Factor, Grid No.2 to Grid No.1	1,2	5.3	8.6	
Direct Interelectrode Capacitances (With no external shield):				
Grid No.1 to plate. . . .	-	0.43	0.75	µµf
Grid No.1 to grid No.2 & internal shield	-	9.1	12.4	µµf
Grid No.1 to cathode and heater.	-	7.0	10.0	µµf
Grid No.2 & internal shield to plate	-	7.8	11.4	µµf
Grid No.2 & internal shield to cathode and heater.	-	-	3.9	µµf
Plate to cathode and heater.	-	-	1.25	µµf
Plate Current	1,3	240	480	ma
Grid-No.2 Current	1,3	-	55	ma
Grid-No.1 Voltage	4	-8	-25	volts
Useful Power Output . . .	1,5	250	-	watts

Note 1: With 6.3 volts ac on heater.

Note 2: With dc plate voltage of 300 volts, dc grid-No.2 voltage of 300 volts, and dc plate current of 150 ma.

Note 3: With dc plate voltage of 300 volts, dc grid-No.2 voltage of 250 volts, and dc grid-No.1 voltage of -5 volts.

Note 4: With dc plate voltage of 300 volts, dc grid-No.2 voltage of 300 volts, and grid-No.1 voltage adjusted to give plate current of 250 ma.

Note 5: In a single-tube, self-excited oscillator circuit at frequency of 60 Mc and for conditions with dc plate voltage of 1250 volts, grid-No.1 resistor of 12000 ohms, dc grid-No.1 current of 6.5 to 9.5 ma, and dc grid-No.2 voltage adjusted to give a plate current of 300 ma.

---

a Subscript 1 indicates that grid-No.1 current does not flow during any part of the input cycle.

b Continuous Commercial Service.

c Intermittent Commercial and Amateur Service.

d The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

e Averaged over any audio-frequency cycle of sine-wave form.

f Obtained preferably from a fixed supply.

g Obtained from a fixed supply.

h "Single-Tone Modulation" operation refers to that class of amplifier service in which the grid-No.1 input consists of a monofrequency rf signal having constant amplitude. This signal is produced in a single-sideband suppressed-carrier system when a single audio frequency of constant amplitude is applied to the input of the system.

j This value of useful power is measured at load of output circuit having indicated efficiency.

k Driver stage is required to supply tube losses and rf circuit losses. The driver stage should be designed to provide an excess of power above the indicated values to take care of variations in line voltage, in components, in initial tube characteristics, and in tube characteristics during life.

m Obtained preferably from a separate source modulated along with the plate supply, or from the modulated plate supply through a series resistor. It is recommended that this resistor be adjustable to permit obtaining the desired operating plate current after initial tuning adjustments are made.

n Obtained from a grid-No.1 resistor or from a combination of grid-No.1 resistor with either fixed supply or cathode resistor. The combination of grid resistor and fixed supply has the advantage of not only protecting the tube from damage through loss of excitation but also of minimizing distortion by bias-supply compensation.

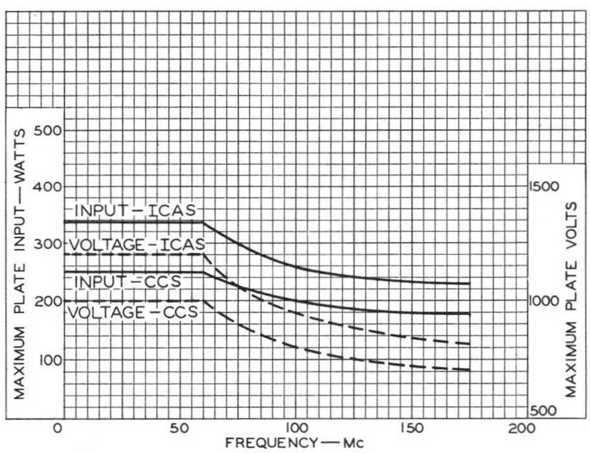
p Indicated values are for operation at 60 Mc. Less driver power output is required at frequencies below 60 Mc.

q When grid No.1 is driven positive the total dc grid-No.1-circuit resistance should not exceed the specified maximum value of 30000 ohms. If this value is insufficient to provide adequate bias, the additional required bias must be supplied by a cathode resistor or fixed supply.

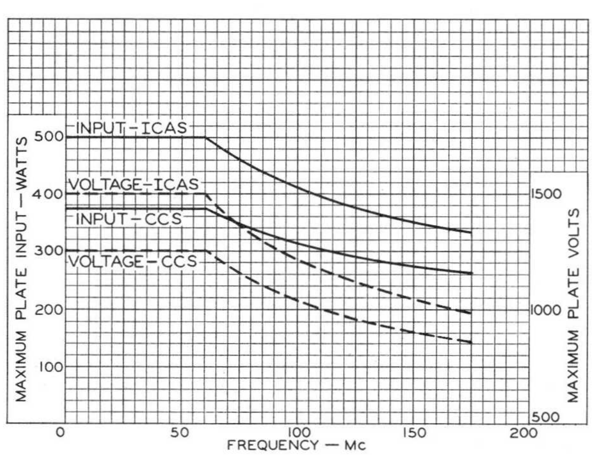
r Key-down conditions per tube without amplitude modulation. Amplitude modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

s Obtained preferably from a separate source or from the plate-voltage supply with a voltage divider. If a series resistor is used, it should be adjustable to permit obtaining the desired operating plate current after initial tuning adjustments are completed. Grid-No.2 voltage must not exceed 500 volts under key-up conditions.

t Obtained from a grid-No.1 resistor, or from a combination of grid-No.1 resistor with either fixed supply or cathode resistor.



Rating Chart I for Type 7094 in Class C Telephony Service.



Rating Chart II for Type 7094 in Class C Telegraphy Service.

OPERATING CONSIDERATIONS

The *maximum bulb temperature* of 250° C is a tube rating and is to be observed in the same manner as other ratings. The temperature should be measured at the hottest point on the bulb with the tube operating in the completely assembled equipment with all covers in place, and delivering the maximum output under the highest ambient-temperature conditions and the most severe operating cycle for which the equipment is designed. The temperature may be measured with temperature-sensitive paint, such as Tempilaq. The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, N.Y., in the form of liquid and stick.

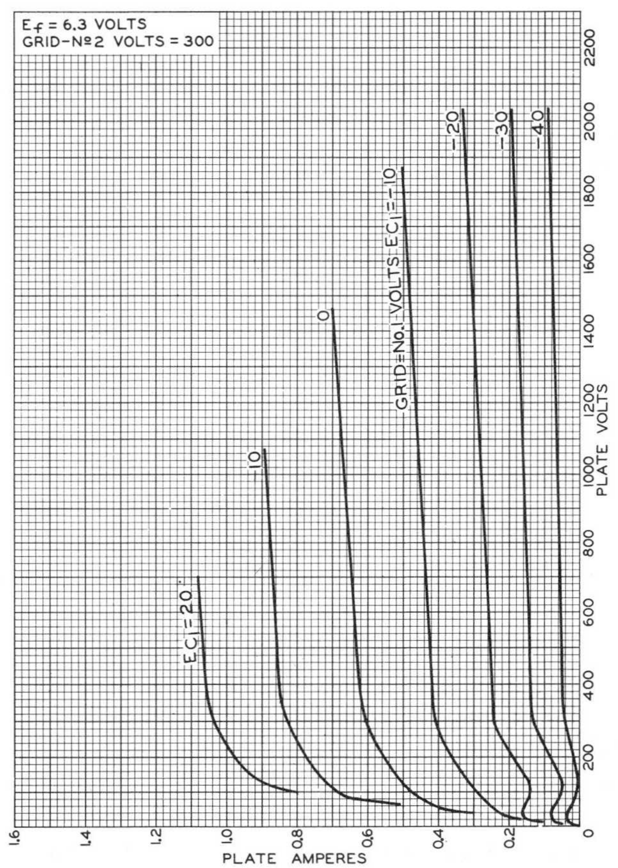


Fig. 1 - Typical Plate Characteristics of Type 7094.

Operation of the 7094 at frequencies above 60 Mc requires reduction in the applied plate voltage and plate input as shown by the Rating Charts I and II. In using these charts, it is to be noted that the maximum plate input that can be applied to the 7094 operating at any given frequency must be chosen, depending on circuit efficiency, so that the plate-dissipation rating of the 7094 will not be exceeded.

The rated plate voltage and grid-No. 2 voltage of this tube are high enough to be dangerous. Care should be taken during adjustment of circuits, especially when exposed circuit parts are at high dc potential.

When a new circuit is tried or when adjustments are made, it is advisable to reduce the plate voltage and grid-No. 2 voltage.

A *protective device*, such as a fuse, should be used to protect not only the plate but also grid No. 2 against overload. In order to prevent excessive plate-current flow and resultant overheating of the tube, the plate circuit should be fused. Similarly, a fuse in the lead to grid No. 2 should remove the grid-No. 2 voltage when the dc grid-No. 2 current reaches a value slightly higher than normal.

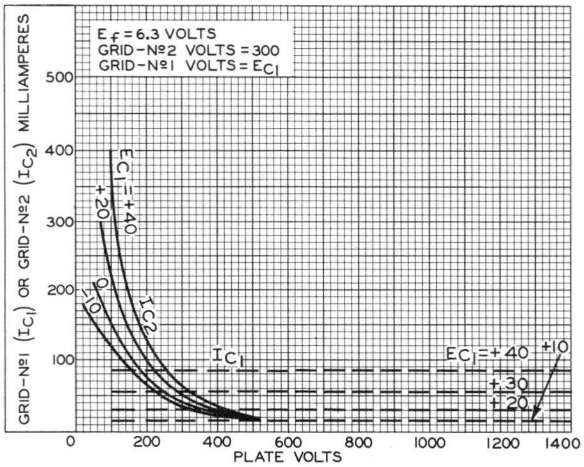


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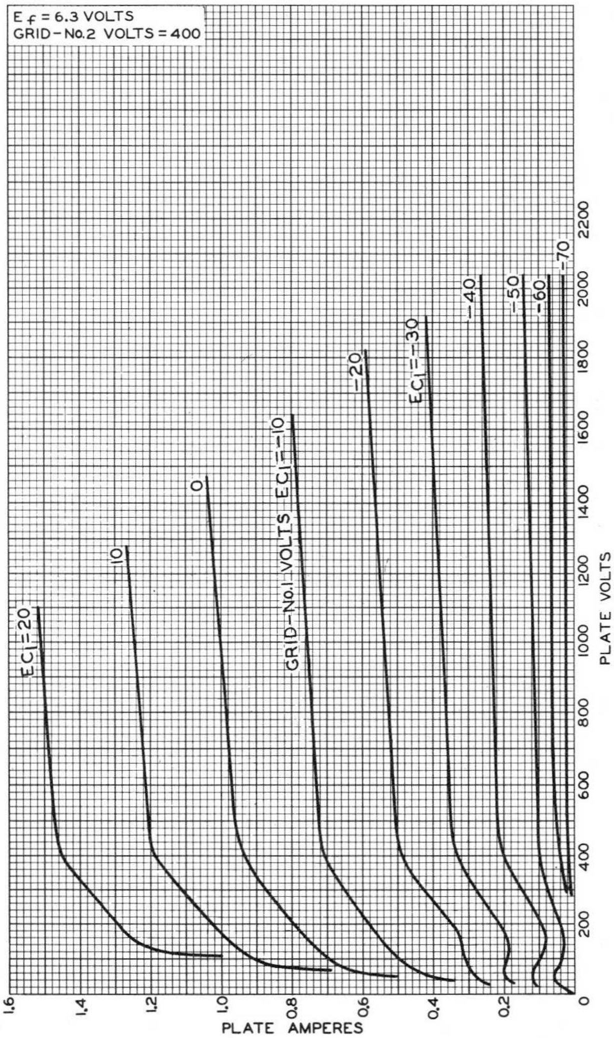
Fig. 2 - Typical Characteristics for Type 7094.

Shielding of the 7094 in rf service is required for stable operation. A convenient method of shielding is to mount the socket approximately 5/8" beneath a hole in the chassis plate so that when the 7094 is inserted in the socket, the internal shield *(see Dimensional Outline)* of the tube will be close to the edge of the hole and in the same plane as the chassis plate. This arrangement provides an effective shield to isolate the grid-No. 1 circuit from the plate circuit.

The connection to the plate terminal should be flexible in order to prevent subjecting the plate-terminal seal to any strain. The connection should never be soldered to the plate terminal. A plate connector of the Fahnestock clip type is recommended.

Heavy leads and conductors together with suitable insulation should be used in all parts of the rf plate tank circuit so that losses due to rf voltages and currents may be kept at a minimum. At the higher frequencies, it is essential that short, heavy leads be used for circuit connections in order to minimize lead inductance and losses.

The *plate* shows no color when the 7094 is operated at maximum rated plate dissipation under



92CM-9502R1

Fig. 3 - Typical Plate Characteristics of Type 7094.

CCS conditions. At maximum rated plate dissipation under ICAS conditions, the plate may show a barely discernible color in a dark room.

The *cathode* should preferably be connected to one side of the heater. When, in some circuit designs, the heater is not connected directly to the cathode, precautions must be taken to hold the peak heater-cathode voltage within the maximum values shown in the tabulated data.

When *grid-No. 2 voltage* is obtained from a separate source, the plate voltage should be applied before or simultaneously with the grid-No.2 voltage; otherwise, with voltage on grid No.2 only, its current would be large enough to cause excessive grid-No.2 dissipation even though some protective bias is employed. When the grid-No.2 voltage is obtained from a voltage divider or through a series resistor from the plate supply, it is recommended that the resistor be adjustable so that the plate current of individual tubes can be adjusted to maintain the desired input. By thus compensating for the normal plate-current variation between tubes, the dc plate input can be held constant to provide more uniform power output and better performance. A dc milliammeter should be used in the grid-No.2 circuit so that its current may be measured and the dc power input determined.

The *rf impedance between grid No.2 and the cathode* must be kept low, usually by means of a

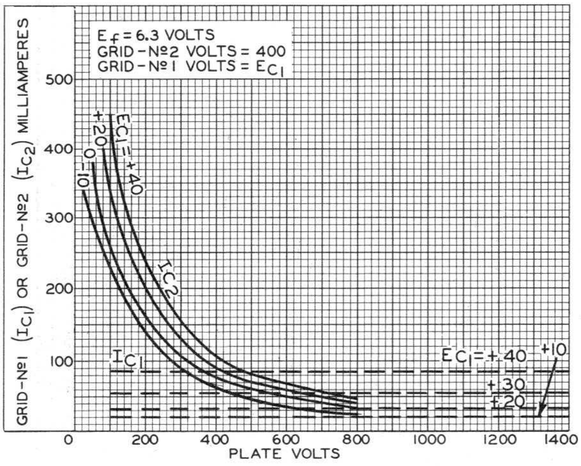


Fig.4 - Typical Characteristics for Type 7094.

suitable bypass capacitor. In telephony service when grid No.2 is modulated, a smaller bypass capacitor than is used for telegraphy service may be required in order to avoid excessive af bypassing. However, if the capacitance value is too small, rf feedback may occur between plate and grid No.1, depending on the circuit layout, operating frequency, and power gain of the stage. AF bypassing difficulties can usually be eliminated if the grid-No.2 bypass capacitor is replaced by a series-resonant circuit which is tuned to resonate at the operating frequency. This circuit presents a high impedance to audic frequencies but a very low impedance to its resonant frequency.

The *grid-No.2 current* is a very sensitive indication of plate-circuit loading. When the amplifier is operated without load, the grid-No.2 current rises excessively, often to a value which damages the tube. Therefore, care should be taken when tuning the 7094 under no-load or lightly loaded conditions to prevent exceeding the grid-No.2 input rating of the tube. In this connection, reduction of the grid-No.2 voltage will be helpful.

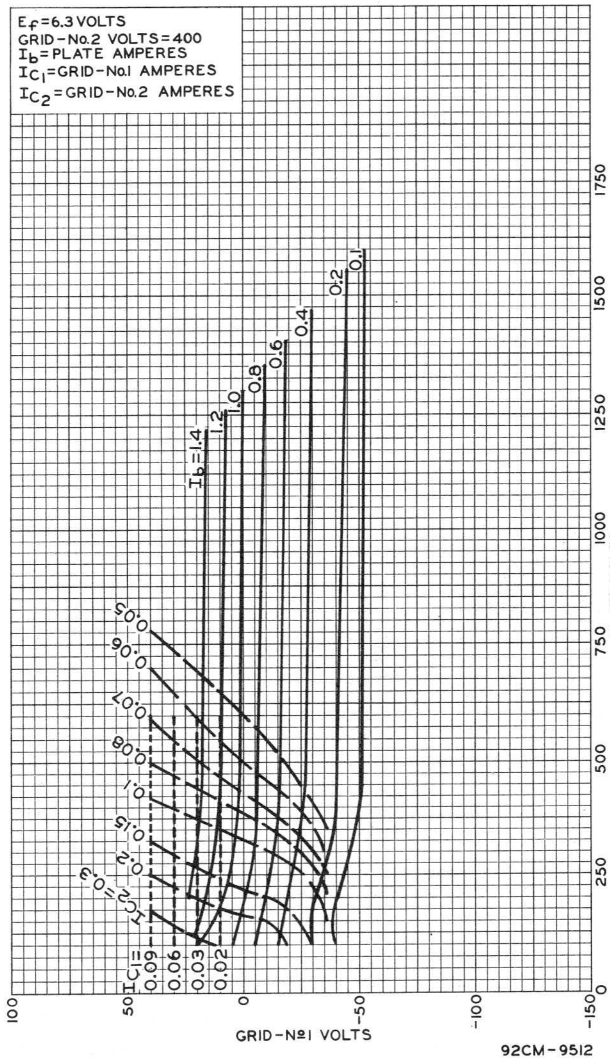


Fig.5 - Typical Constant-Current Characteristics for Type 7094.

The *driver stage* for the 7094 in either class C telephony or telegraphy service should have considerably more output capability than the typical driving power shown in the tabulated data in order to permit considerable range of adjustment, and also to provide for losses in the grid-No.1 circuit and the coupling circuit. This recommendation is particularly important near the rated maximum frequency where circuit losses, radiation losses, and transit-time losses increase. These losses have been taken into account in the values of driver power output shown under Typical Operation.

Highest operating efficiency in high-frequency service, and therefore maximum power output, will be obtained when the 7094 is operated under load conditions such that the maximum rated plate current flows at the plate voltage which will give maximum rated input.

In *plate-modulated class C amplifier service*, the 7094 can be modulated 100 per cent. The grid-No.2 voltage must be modulated simultaneously with the plate voltage so that the ratio of grid-No.2 voltage to plate voltage remains constant. Modulation of the grid-No.2 voltage can be accomplished either by connecting grid No.2 through a separate winding on the modulation transformer to the fixed grid-No.2 voltage supply, or by connecting grid No.2 through an audio-frequency choke of suitable impedance for low audio frequencies to the fixed grid-No.2 supply voltage. The supply end of the choke should be well by-passed to ground.

During standby periods in intermittent operation, it is recommended that the heater voltage be maintained at normal operating value when the period is less than 15 minutes; and that it be reduced to 80 per cent of normal when the period is between 15 minutes and 2 hours. For longer periods, the heater voltage should be turned off.

Push-pull or parallel circuit arrangements can be used when more radio-frequency power is required than can be obtained from a single 7094. Two 7094's in parallel or push-pull will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage from that required for a single tube. With either connection, the driving power required is approximately twice that for a single tube. The push-pull arrangement has the advantage of simplifying the balancing of high-frequency circuits.

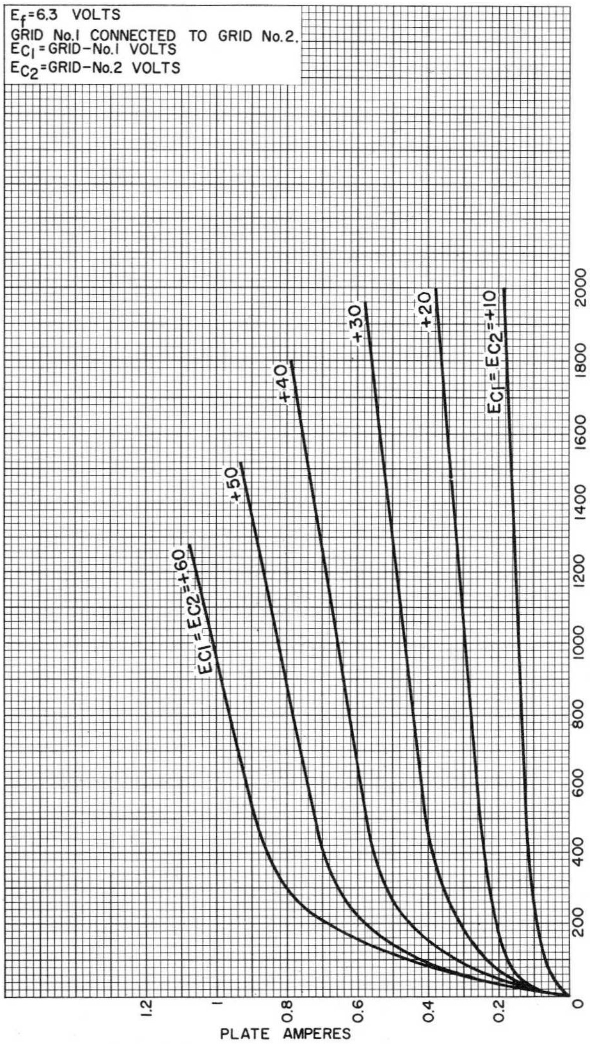


Fig. 6 - Typical Characteristics for Type 7094 Connected as Triode.

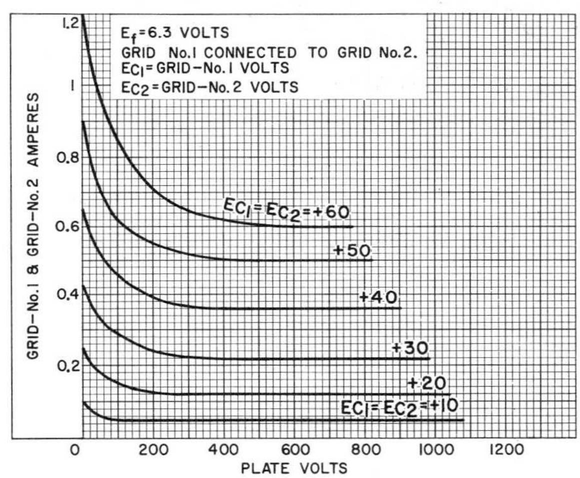


Fig. 7 - Typical Characteristics for Type 7094 Connected as Triode.

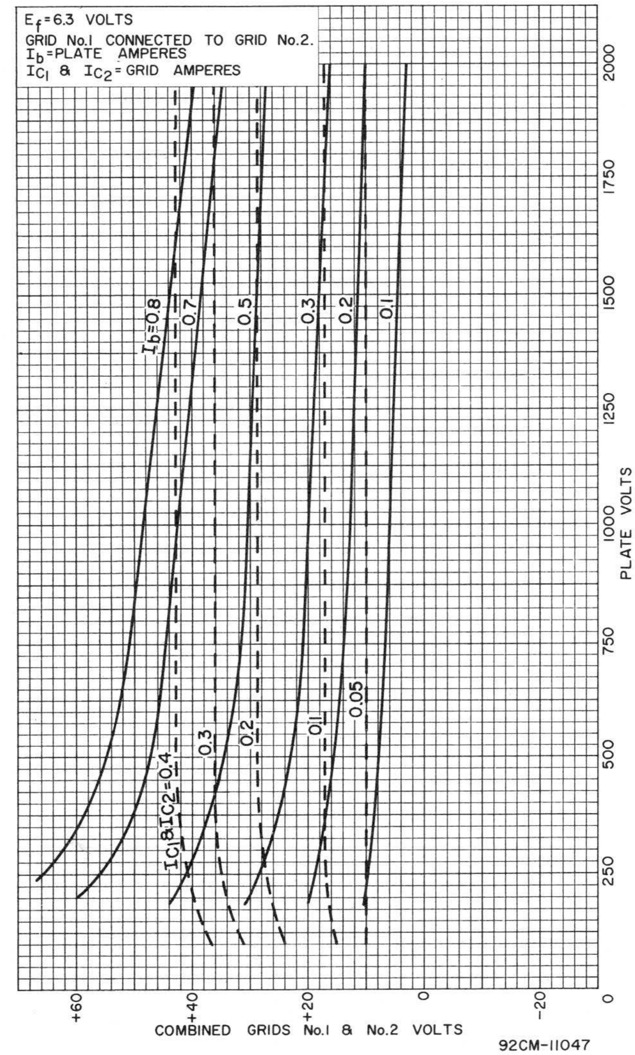
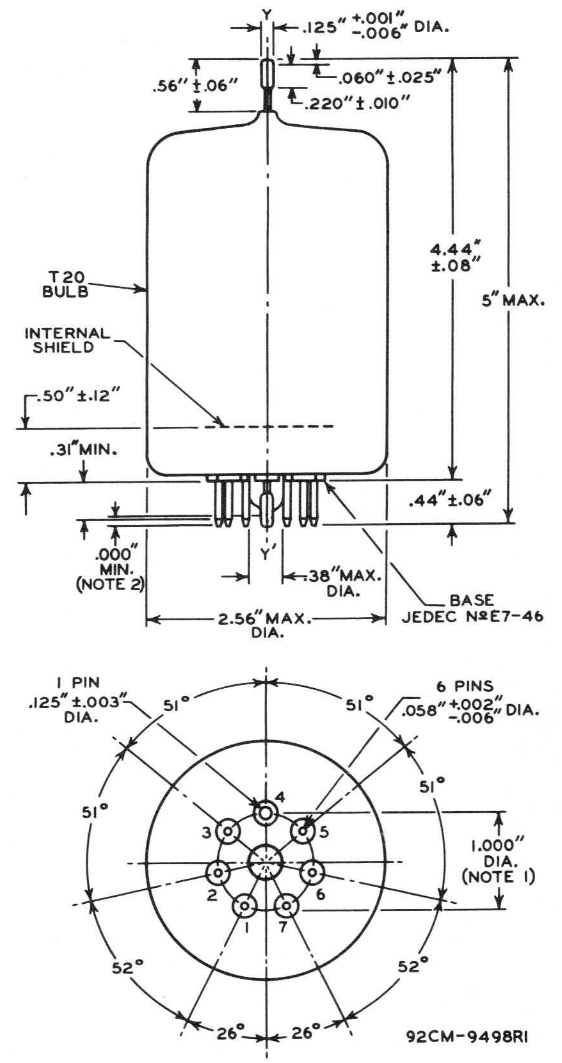


Fig. 8 - Typical Constant-Current Characteristics For Type 7094 Connected as a Triode.

DIMENSIONAL OUTLINE



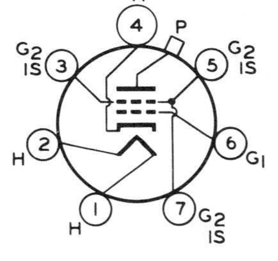
THE REFERENCE AXIS Y-Y' IS DEFINED AS THE AXIS OF THE BASE PIN GAUGE DESCRIBED IN NOTE 1:

NOTE 1: ANGULAR VARIATIONS BETWEEN PINS AND VARIATION IN PIN-CIRCLE DIAMETER ARE HELD TO TOLERANCES SUCH THAT PINS WILL ENTER TO A DISTANCE OF 0.375" A FLAT-PLATE BASE-PIN GAUGE HAVING SIX HOLES 0.0800" ± 0.0005" AND ONE HOLE 0.1450" ± 0.0005" ARRANGED ON A 1.0000" ± 0.0005" CIRCLE AT SPECIFIED ANGLES WITH TOLERANCE OF ± 5' FOR EACH ANGLE. GAUGE IS ALSO PROVIDED WITH A HOLE 0.500" ± 0.010" CONCENTRIC WITH PIN CIRCLE WHOSE CENTER IS ON THE AXIS Y-Y'.

NOTE 2: EXHAUST TIP WILL NOT EXTEND BEYOND THE PLANE WHICH PASSES THROUGH THE ENDS OF THE THREE LONGEST PINS.

BASING DIAGRAM
Bottom View

PIN 1: HEATER
PIN 2: HEATER
PIN 3: GRID No.2, INTERNAL SHIELD
PIN 4: CATHODE



PIN 5: GRID No.2, INTERNAL SHIELD
PIN 6: GRID No.1
PIN 7: GRID No.2, INTERNAL SHIELD
P: PLATE

H-887

Photomultiplier Tube

RCA-7102

10-Stage, Head-On Type Having S-1 Spectral Response

RCA-7102 is a 1-1/2"-diameter, 10-stage, head-on type of photomultiplier tube designed for the detection and measurement of low-level radiation extending from the visible to near-infrared region of the spectrum.

The S-1 spectral response of this tube covers the range from about 4500 to 11500 angstroms making it especially useful for near-infrared spectrometry, astronomical measurements, laser detection systems, and near-infrared communication systems.

- **S-1 Spectral Response Covering the Approximate Spectral Range from 4500 to 11500 Angstroms**
- **Circular-Cage, Electrostatic-Focus Type Dynode Structure**
- **High-Stability Copper-Beryllium Dynodes**
- **Photocathode Having Minimum Useful Diameter of 1.24"**
- **Time Resolution Characteristics:**
  Anode Pulse Rise Time—
  2.2 nanoseconds at 1500 volts
  Electron Transit Time—
  28 nanoseconds at 1500 volts

Data

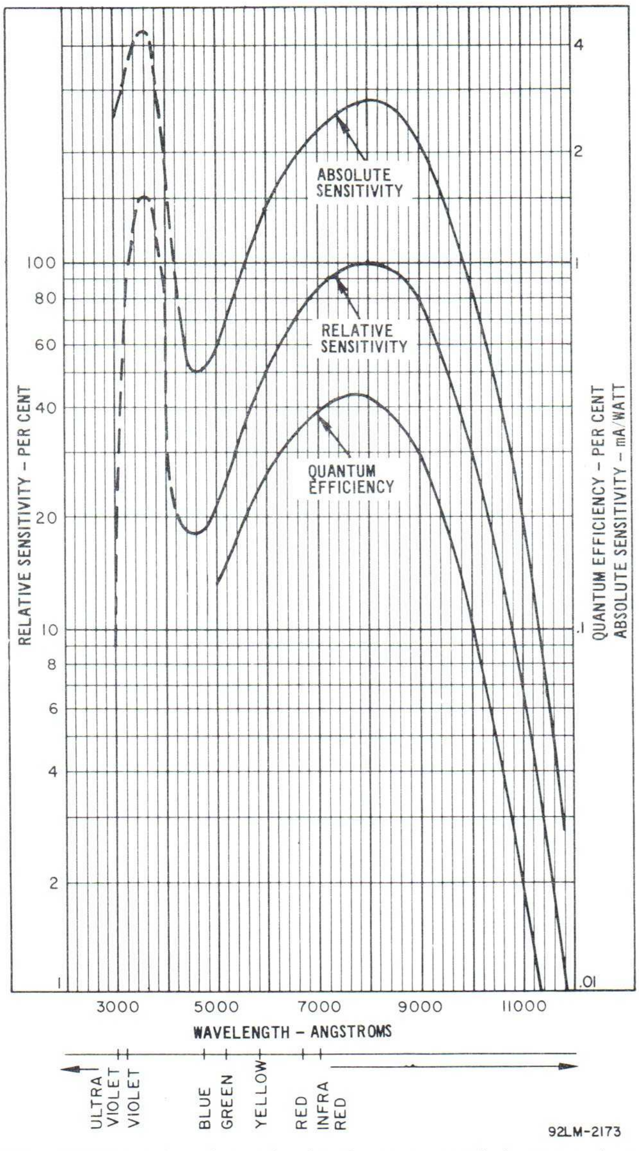
General:

Spectral Response S-1
Wavelength of Maximum Response . . . . . . 8000 ± 1000 Å
Cathode, Semitransparent . . . . . . Silver-Oxygen-Cesium
Minimum area . . . . $1.2\ in^2$ ($7.7\ cm^2$)
Minimum diameter . . . . 1.24 in (3.1 cm)
Window . . . . . Lime Glass (Corning[a] No.0080) or equivalent
Shape . . . . Plano-Plano
Index of refraction at 5893 angstroms 1.512

Dynodes:

Substrate . . . . Copper-Beryllium
Secondary-Emitting Surface . . . . . . Beryllium-Oxide
Structure . . . . . . Circular-Cage, Electrostatic-Focus Type

Typical Spectral Response Characteristics



The dashed portion shown in the above curve of the spectral response is not controlled.

Figure 1

Direct Interelectrode Capacitances (Approx.):

Anode to dynode No.10	4 pF
Anode to all other electrodes	7 pF
Maximum Overall Length	4.57 in (11.6 cm)
Seated Length	3.88 in ± 0.19 in (9.8 ± 0.48 cm)
Maximum Diameter	1.56 in
Bulb	T12
Base	Small-Shell Duodecal 12-Pin (JEDEC B12-43), Non-hygroscopic
Socket	Eby[b] No.9058, or equivalent
Magnetic Shield	Millen[c] No.80802C, or equivalent
Operating Position	Any
Weight (Approx.)	2.2 oz (60 g)

Maximum Ratings, *Absolute-Maximum Values:*[d]

DC Supply Voltage:

Between anode and cathode	1500	max.	V
Between anode and dynode No.10	250	max.	V
Between consecutive dynodes	200	max.	V
Between dynode No.1 and cathode	400	max.	V
Average Anode Current[e]	10	max.	µA
Ambient Temperature[f]	75	max.	°C

Characteristics Range Values for Equipment Design:

Under conditions with supply voltage (E) across voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode.

With E = 1250 volts (Except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
→ Radiant[g] at 8000 angstroms	–	6.6×10^{2}	–	A/W
→ Luminous[h] (2870° K)	1	7	30	A/lm
Cathode Sensitivity:				
→ Radiant[j] at 8000 angstroms	–	2.8×10^{-3}	–	A/W
Luminous[k] (2870°K)	1×10^{-5}	3×10^{-5}	–	A/lm
→ Current with infrared light source[m] (2870° K + C.S. No.7-56)	1.2×10^{-8}	4×10^{-8}	–	A
→ Quantum Efficiency at 7800 angstroms	–	0.43	–	%
→ Current Amplification	–	2.3×10^{5}	–	
→ Anode Dark Current[n]	–	1.9×10^{-6}	6×10^{-6}	A
→ Equivalent Anode Dark Current Input[n]	–	4.8×10^{-7}	1.5×10^{-6}	lm
	–	5.1×10^{-9}[p]	1.6×10^{-8}[p]	W
Equivalent Noise Input[q]	–	1.5×10^{-10}	–	lm
	–	1.6×10^{-12}[r]	–	W
→ Anode-Pulse Rise Time[s] at 1500 V	–	2.2×10^{-9}	–	s
→ Electron Transit Time[t] at 1500 V	–	2.8×10^{-8}	–	s

→ Indicates a change or addition.

a Made by Corning Glass Works, Corning, NY 14830.

b Made by Hugh H. Eby Company, 4701 Germantown Avenue, Philadelphia, PA 19144.

c Made by James Millen Manufacturing Company, 150 Exchange Street, Malden, MA 02148.

d The maximum ratings in the tabulated data are established in accordance with the following definition of the Absolute-Maximum Rating System for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

e Averaged over any interval of 30 seconds maximum. When stability of operation is important, the use of an average anode current well below the maximum rated value of 10 microamperes is recommended. This maximum rating should never be exceeded because operation at higher average output currents may cause a permanent decrease in infrared sensitivity and a consequent decrease in the tube life.

f Tube operation at room temperature or below is recommended.

g This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 94 lumens per watt.

h Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K and a light input of 10 microlumens is used.

j This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 94 lumens per watt.

k Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K. The value of light flux is 0.01 lumen and 250 volts are applied between cathode and all other electrodes connected as anode.

m Under the following conditions: Light incident on the cathode is transmitted through an infrared filter (C.S. No.7-56, manufactured by Corning Glass Works, Corning, NY 14830) from a tungsten-filament lamp operated at a color temperature of 2870° K. The value of light flux incident on the filter is 0.01 lumen, and 250 volts are applied between cathode and all other electrodes connected as anode.

n At a tube temperature of 22° C. With supply voltage adjusted to give a luminous sensitivity of 4 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant.

p At 8000 angstroms. These values are calculated from the EADCI values in lumens using a conversion factor of 94 lumens per watt.

q Under the following conditions: Tube temperature 22° C, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

r At 8000 angstroms. This value is calculated from the ENI value in lumens using a conversion factor of 94 lumens per watt.

s Measured between 10 per cent and 90 per cent of maximum anode-pulse height. This anode-pulse rise time is primarily a function of transit time variation and is measured under conditions with the incident light fully illuminating the photocathode.

t The electron transit time is the time interval between the arrival of a delta function light pulse at the entrance window of the tube and the time at which the output pulse at the anode terminal reaches peak amplitude. The transit time is measured under conditions with the incident light fully illuminating the photocathode.

Operating Considerations

Terminal Connections

The base pins of the 7102 fit a duodecal 12-contact socket, such as Eby No.9058, or equivalent. The basing arrangement is such that the voltage between anode pin and adjacent pins is not more than twice the voltage per stage. As a result, external leakage between anode pin and adjacent pins is kept low.

Ambient Atmosphere

Operation or storage of this tube in environments where helium is present should be avoided. Helium may permeate through the tube envelope and may lead to eventual tube destruction.

Anode Current

The operating stability of the 7102 is dependent on the magnitude of the anode current. The use of an average anode current well below the maximum rated value of 10 microamperes is recommended when stability of operation is important. This maximum rating should never be exceeded because operation at higher average output currents may cause a permanent decrease in infrared sensitivity and a consequent decrease in the tube life.

Dark Current

A very small anode dark current is observed when voltage is applied to the electrodes of these tubes in complete darkness. Among the components contributing to dark current are ohmic leakage between the anode and adjacent elements and pulses produced by electrons thermionically released from the cathode, secondary electrons released by ionic bombardment of the dynodes, support rods, or cathode, and by cold emission from the electrodes.

Typical anode dark current and EADCI as a function of luminous sensitivity at a temperature of +22° C is shown in **Figure 7.**

In either dc or ac applications where maximum gain with unusually low dark current is required, the use of a refrigerant, such as dry ice, to cool the photocathode of the 7102 is recommended. The refrigerant reduces the thermionic emission, and thereby lowers the detection threshold to give improved operation. The curves in **Figure 6** show the equivalent noise input as a function of the temperature of the 7102.

A temporary increase in anode dark current by as much as 3 orders of magnitude may occur if these tubes are exposed momentarily to high-intensity ultraviolet radiation from sources such as fluorescent room lighting even though voltage is not applied to the tubes. The increase in dark current may persist for a period of 24 to 48 hours following such irradiation.

Schematic Arrangement of Structure

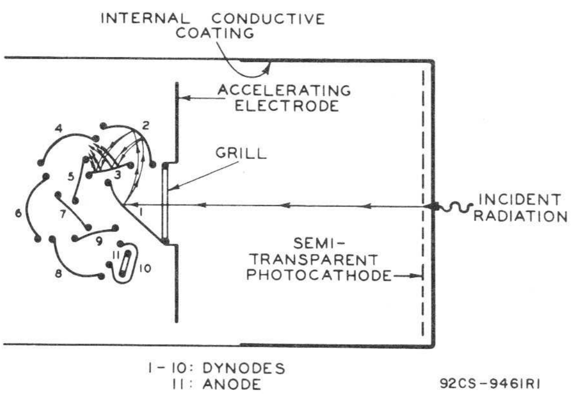


Figure 2

Shielding

Electrostatic shielding of the tube is ordinarily required. When a shield is used, it must be connected to the cathode terminal. The application of high voltage, with respect to cathode, to insulating or other materials supporting or shielding the tube at the photocathode end should not be permitted unless such materials are chosen to limit leakage current to the tube envelope to 1×10^{-12} ampere or less.

In addition to increasing dark current and noise output because of voltage gradients developed across the bulb wall, such high voltage may produce minute leakage current to the cathode, through the tube envelope and insulating materials, which can permanently damage the tube.

Electrostatic and/or magnetic shielding of the 7102 may be necessary. The metallic coating on the inner side wall of the glass bulb serves as an electrostatic shield to prevent the coated portion of the bulb wall from charging to a positive potential. However, the uncoated area of the bulb wall tends to charge to a potential near that of the anode, especially when the 7102 is operated at voltages near the maximum ratings. In addition to causing an increase in noise output this condition may also result in permanent tube damage. To prevent this possibility any external shield must be connected to cathode potential.

Typical Time Resolution Characteristics

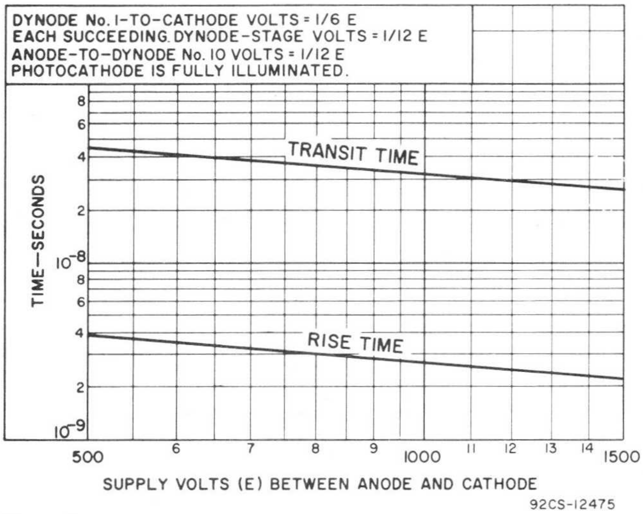


Figure 3

Magnetic shielding of the 7102 may be necessary if it is operated in the presence of strong magnetic fields. The curve in **Figure 9** shows the effect of variation in magnetic-field strength on anode current under the conditions indicated. With increase in voltage above 100 volts between cathode and dynode No.1, the effect of a given magnetic field will cause less decrease in anode current.

It is to be noted that the use of an external shield at high negative potential presents a safety hazard unless the shield is connected through a high resistance in the order of 10 megohms to the negative potential source. If the shield is not so connected, extreme care should be observed in providing adequate safeguards to prevent personnel from coming in contact with the high potential of the shield.

Adequate visible and infrared-radiation shielding should be provided to prevent extraneous radiation from reaching any part of the 7102. Although the metallic coating on the inner side wall of the face end of the envelope serves to reduce the amount of such radiation reaching the electrodes, it is inadequate to shield completely the entire tube structure.

Sensitivity and Current Amplification Characteristics

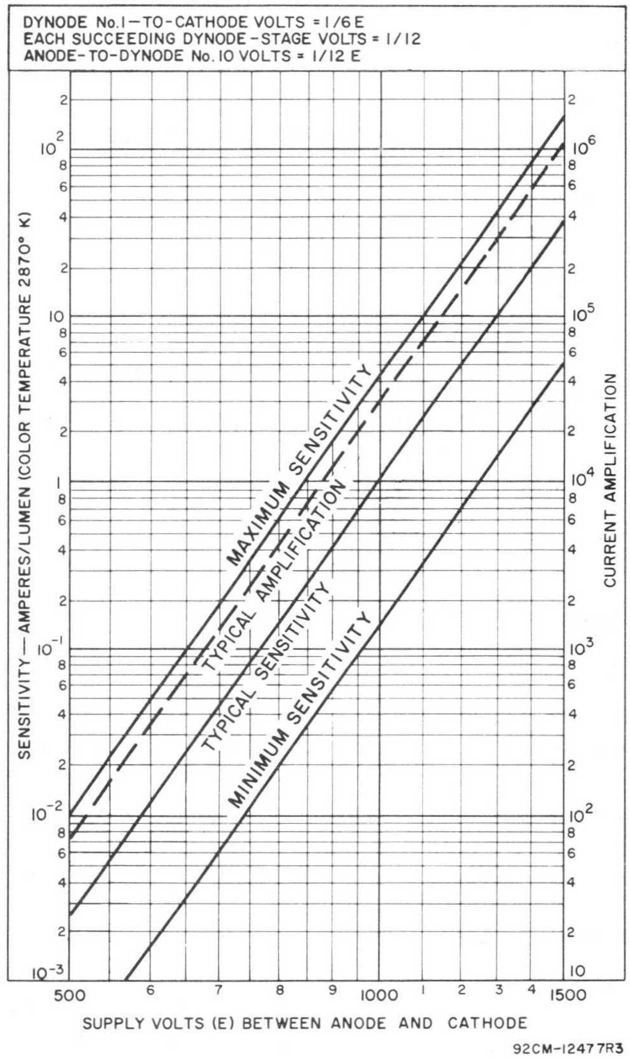


Figure 4

Operating Voltages

In general, the operating potential between anode and cathode should not be less than 500 volts.

The operating voltage between dynode No.10 and anode should be kept as low as will permit operation over the knee of the anode characteristic curves shown in **Figure 8.** With low operating voltage between dynode No.10 and anode, the ohmic leakage current to the anode is reduced. Operation over the knee occurs in the approximate range of 50 to 100 volts for the light level range shown in **Figure 8.** Under high pulse current conditions, saturation due to space-charge limitations will occur and higher voltage will be required. To obtain the suggested operating voltage between dynode No.10 and anode, it is necessary to increase the supply voltage between these electrodes by an amount equal to the voltage drop across a particular output load.

In applications where it is desired to keep the statistical fluctuations to a minimum, e.g., as in astronomical measurements, the potential between cathode and dynode No.1 may be increased to the rated maximum value of 400 volts.

When the application utilizes continuous luminous excitation and dc anode current and it is desired to have a high ratio of signal output to dark current, it is recommended that the operating supply voltage (E) be determined with reference to the curve in **Figure 7** which shows the equivalent anode-dark-current input as a function of luminous sensitivity for the 7102, and the curves in **Figure 4** which show luminous sensitivity as a function of the supply voltage.

In applications involving pulsed excitation and ac coupling at the anode, the best signal-to-noise ratio is obtained with a supply voltage (E) in the range from 850 to 1250 volts. Within this range, the noise at the anode is produced primarily by the statistical release of thermal electrons, and the noise power spectrum is essentially flat up to about 50 megahertz per second. At voltages above 1250 volts, regenerative phenomena usually contribute to the noise.

The noise spectrum of the 7102 is such that the threshold of pulse detection depends on the associated circuitry. The bandpass filter should be designed to pass only the frequency range of the exciting signal in order to eliminate as much noise as possible.

Whenever frequency response is important, the leads from the 7102 to the load circuit should be as short as possible.

A typical voltage-divider arrangement for use with the 7102 is shown in **Figure 10.** Recommended resistance values for the voltage divider range from 10,000 ohms per stage to 1 megohm per stage. The choice of resistance values for the voltage-divider network is usually a compromise. If low values of resistance per stage are utilized, the power drawn from the regulated power supply and the required wattage rating of the resistors increase. Phototube noise may also increase due to heating. The divider network and other heat producing components should not be located so that they will increase the photocathode temperature. The use of resistance values near 1 megohm per stage may cause deviation from linearity if the voltage-divider current is not maintained at a value several times that of the maximum value of anode current, and may limit anode-current response to pulsed light. The latter effect may be reduced by connecting capacitors between the tube socket terminals for dynodes No.9 and No.10, and between dynode No.10 and anode return. In addition to nonlinearity and pulse-limiting effects, the use of resistance values exceeding 1 megohm per stage make the 7102 more susceptible to leakage effects between terminals with possible resulting deviation in interstage voltage leading to a loss of current amplification.

In most applications, it is recommended that the positive high-voltage terminal be grounded in order that the output signal will be produced between anode and ground. This method prevents power-supply fluctuations from being coupled directly into the signal-output circuit. When the 7102 is operated in this manner, the electrostatic shield must be connected to the cathode for maximum signal-to-noise ratio.

The high voltages at which the 7102 is operated are very dangerous. Care should be taken in the design of apparatus to prevent the operator from coming in contact with these high voltages.

Leads to all capacitors should be as short as possible to minimize inductance effects. The location and spacing of capacitors is critical and may require adjustment for optimum results.

The capacitor values will depend upon the shape and the amplitude of the anode-current pulse, and the time duration of the pulse, or train of pulses. When the output pulse is assumed to be rectangular in shape, the following formula applies:

$$C = 100 \frac{i \cdot t}{V}$$

where C is in farads
i is the amplitude of anode current in amperes
V is the voltage across the capacitor in volts
and t is the time duration of the pulse in seconds

This formula applies for the anode-to-final dynode capacitor. The factor 100 is used to limit the voltage change across the capacitor to 1% maximum during a pulse. Capacitor values for preceding stages should take into account the smaller values of dynode currents in these stages. Conservatively, a factor of approximately 2 per stage is used. Capacitors are not required across those dynode stages where the dynode current is less than 1/10 of the current through the voltage-divider network.

For other shaped pulses or for a train of pulses, the total charge q should be substituted for (i·t) and the following formula applies:

$$C = 100 \frac{q}{V}$$

where $q = \int i(t)\, dt$ coulombs

Spectral Characteristic of Radiation From 2870° K Light Source After Passing Through Infrared Filter (Corning C.S. No.7-56)

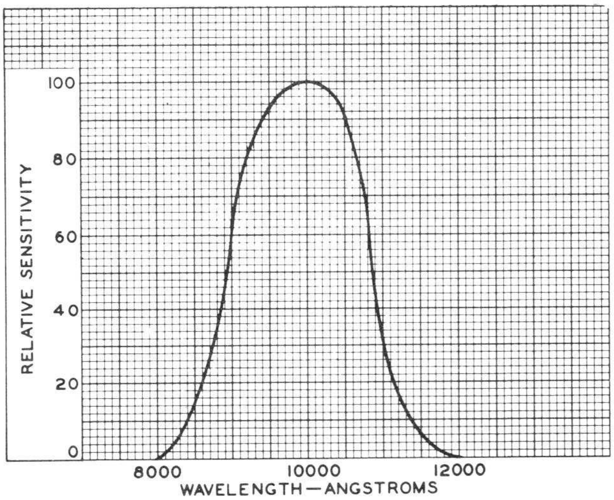


Figure 5

Equivalent Noise-Input Characteristics

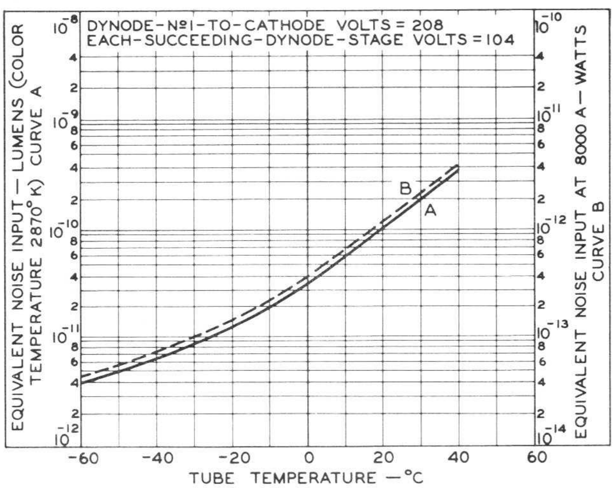


Figure 6

Typical EADCI and Anode Dark Current Characteristics

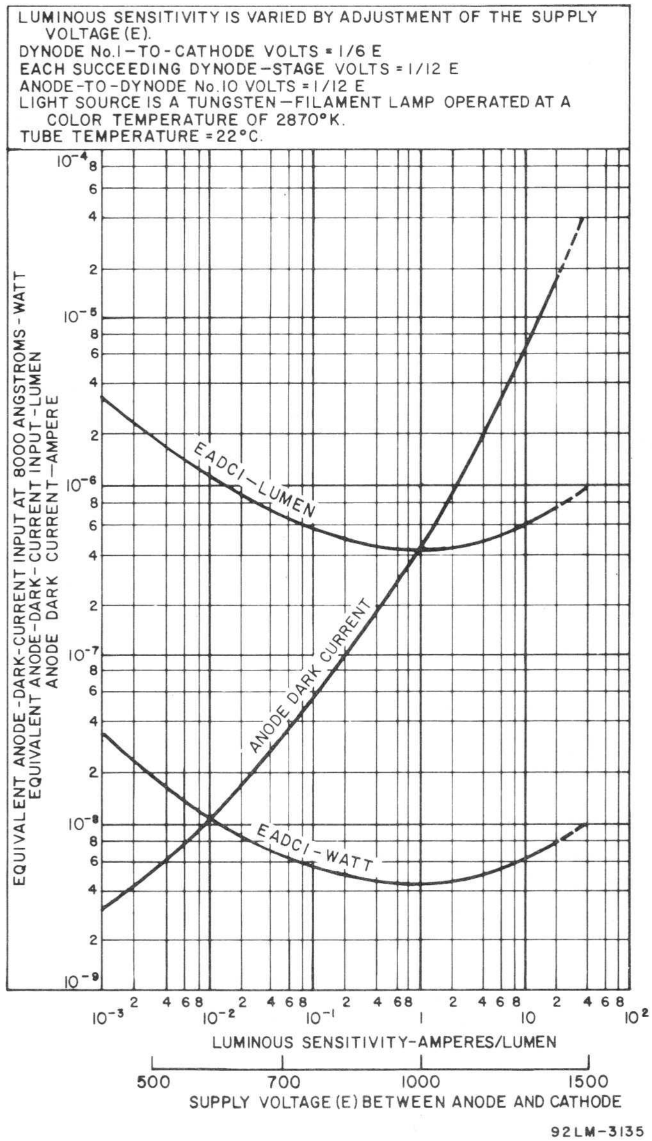


Figure 7

Typical Anode Characteristics

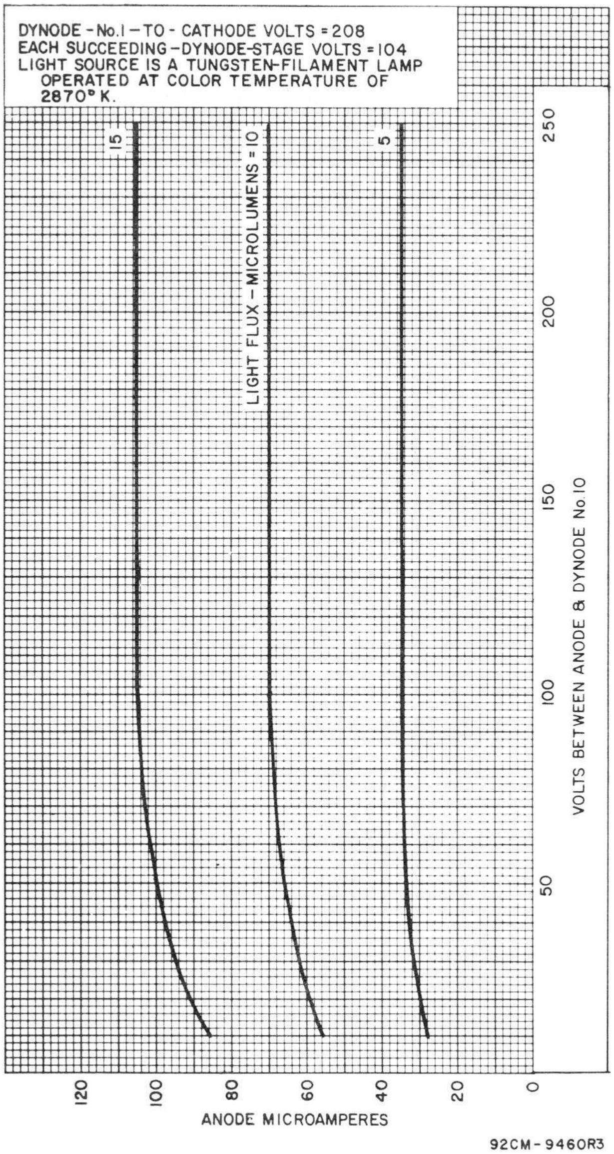


Figure 8

Typical Effect of Magnetic Field on Anode Current

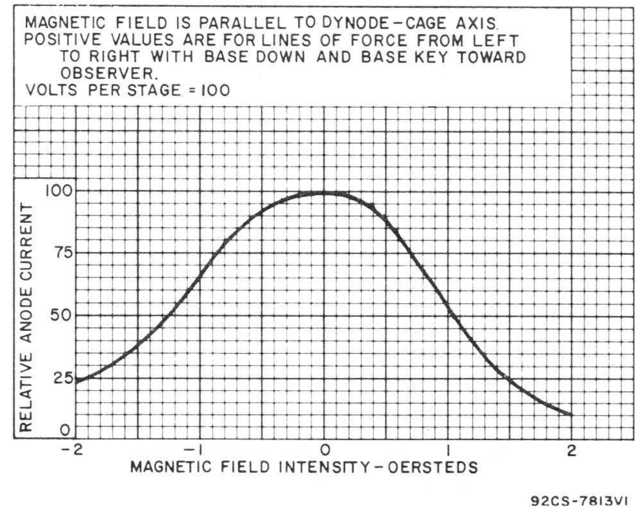
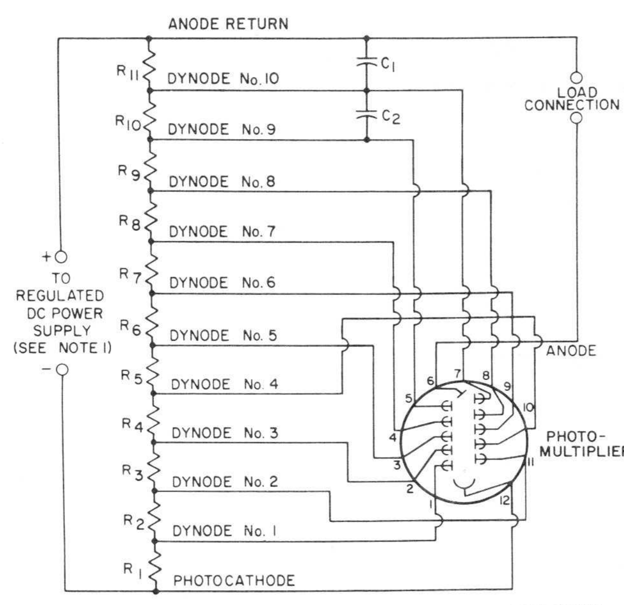


Figure 9

Typical Voltage-Divider Arrangement



C_1: 0.02 μF, 20%, 500 volts (dc working), ceramic disc
C_2: 0.01 μF, 20%, 500 volts (dc working), ceramic disc
R_1: 910,000 ohms, 2 watts
R_2 through R_{11}: 470,000 ohms, 1 watt

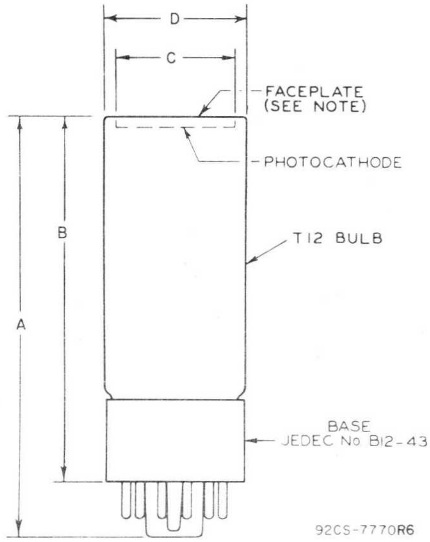
Note 1: Adjustable between approximately 500 and 1500 volts dc.

Note 2: Capacitors C_1 and C_2 should be connected at tube socket for optimum high-frequency performance.

Note 3: Component values are dependent upon nature of application and output signal desired. See discussion on Typical Voltage Divider Arrangements — page 4.

Figure 10

Dimensional Outline

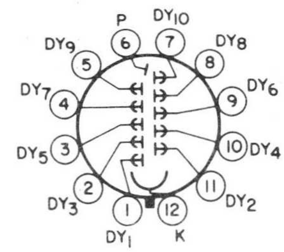


Note: Deviation from flatness will not exceed 0.010" from peak to valley.

℄ of bulb will not deviate more than 2° in any direction from the perpendicular erected at the center of bottom of the base.

Dimensions	Inches	mm
A	4.57 max.	116.1 max.
B	3.88 ± 0.19	98.5 ± 4.8
C	1.24 min. dia.	31.4 min. dia.
D	1.56 max. dia.	39.6 max. dia.

Basing Diagram Bottom View



DIRECTION OF RADIATION:
INTO END OF BULB

12AE

Pin 1: Dynode No.1
Pin 2: Dynode No.3
Pin 3: Dynode No.5
Pin 4: Dynode No.7
Pin 5: Dynode No.9
Pin 6: Anode
Pin 7: Dynode No.10
Pin 8: Dynode No.8
Pin 9: Dynode No.6
Pin 10: Dynode No.4
Pin 11: Dynode No.2
Pin 12: Photocathode

RCA

7203/4CX250B

BEAM POWER TUBE

This bulletin also applies to RCA-7204/4CX250F which is identical with RCA-7203/4CX250B except for its heater rating of 26.5 ± 10% volts, 0.58 ampere. The 7204 is unilaterally interchangeable with the 4X250F and bilaterally interchangeable with the 4CX250F.

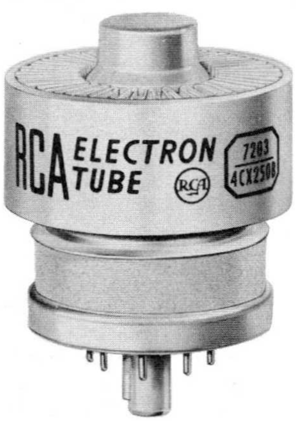
7204/4CX250F

Ceramic-Metal Seals
Coaxial-Electrode Structure
Compact Design

For Use at Frequencies up to 500 Mc
Forced-Air Cooled
400 Watts CW Output to 175 Mc
250 Watts CW Output at 500 Mc

2.464" Max. Length
1.640" Max. Diameter
Integral Radiator

RCA-7203/4CX250B is a very small and compact forced-air-cooled beam power tube constructed with ceramic-metal seals throughout and having a maximum plate dissipation of 250 watts. It is intended for service as an af power amplifier and modulator, a wide-band amplifier in video applications, a linear rf power amplifier in single-sideband suppressed-carrier equipment, and a class C amplifier and oscillator. The 7203 can be used with full ratings at frequencies up to 500 megacycles per second.



The ceramic-metal-seal construction employed in the 7203 permits operation at higher temperatures than a glass-seal construction and thus provides improved reliability. The specially designed, high-efficiency radiator which is brazed directly to the plate for better heat transfer, makes possible the maximum plate-dissipation rating of 250 watts with no sacrifice in tube reliability.

The terminal arrangement of the 7203 facilitates use of the tube with tank circuits of the coaxial type. Effective isolation of the output circuit from the input circuit is provided at the higher frequencies by the ring terminal for grid No.2. A base-pin termination for grid No.2 is also available for operation of the 7203 at the lower frequencies.

The 7203 is unilaterally interchangeable with the 4X250B and bilaterally interchangeable with the 4CX250B.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)§	6.0 ± 10%	volts
Current at 6.0 volts	2.6	amp
Minimum heating time	30	seconds
Mu-Factor, Grid No.2 to Grid No.1, for grid-No.2 volts = 300 and grid-No.2 ma. = 50	5.0	
Direct Interelectrode Capacitances (Approx.):□		
Grid No.1 to plate	0.03	μμf
Grid No.1 to cathode, grid No.2, and heater	16	μμf
Plate to cathode, grid No.2, and heater	4.4	μμf

Mechanical:

Operating Position .Any
Maximum Overall Length . . . . 2.464"
Maximum Seated Length. . . . . 1.910"
Maximum Diameter . . . . 1.640"
Base . . . . .Special 8-Pin
Socket . . . . Air-System Socket, such as SK-600■ and SK-606 Air Chimney■; or 124-110-1▬ (Supplied with Air Chimney)
Radiator . . . . .Integral part of tube

Air Flow:

Through Indicated Air-System Socket--This fitting directs the air over the base seals; past the grid-No.2 seal, envelope, and plate seal; and through the radiator to provide effective cooling with minimum air flow. When the tube is operated at maximum plate dissipation for each class of service, a minimum air flow of 3.8 cfm through the system is required. The corresponding pressure drop is approximately 0.3 inch of water. These requirements are for operation at sea level and at an ambient temperature of 20° C. At higher altitudes and ambient temperatures, the air flow must be increased to maintain the respective seal temperatures and the plate temperature within maximum ratings.

Without Air-System Socket--If an air-system socket is not used, it is essential that adequate cooling air be directed over the base seals, past the envelope, and through the radiator. Under these conditions and with the tube operating at maximum plate dissipation for each class of service, a minimum air flow of 3.6 cfm must pass through the radiator. The corresponding pressure drop is approximately 0.1 inch of water. These requirements are for operation at sea level and at an ambient temperature of 20° C. At higher altitudes and ambient temperatures, the air flow must be increased to maintain the respective seal temperatures and the plate temperature within maximum ratings.

Plate Temperature (Measured on base end of plate surface at junction with fins)	250 max.	°C
Temperature of Plate Seal, Grid-No.2 Seal, and Base Seals	250 max.	°C
Weight (Approx.)	4	ounces

■ Available from Eitel-McCullough, Inc., San Bruno, Calif.
▬ Available from E. F. Johnson Co., Waseca, Minn.

AF POWER AMPLIFIER & MODULATOR—Class AB_1♦

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

DC PLATE VOLTAGE	2000 max.	volts
DC GRID-No.2 VOLTAGE	400 max.	volts
MAX.-SIGNAL DC PLATE CURRENT*	250 max.	ma
PLATE DISSIPATION*	250 max.	watts
GRID-No.2 DISSIPATION*	12 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	150 max.	volts
Heater positive with respect to cathode	150 max.	volts

Typical CCS Operation:

Values are for 2 tubes

DC Plate Voltage	1000	1500	2000	volts
DC Grid-No.2 Voltage	350	350	350	volts
DC Grid-No.1 Voltage	-55	-55	-55	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	94	94	94	volts
Zero-Signal DC Plate Current	166	166	166	ma
Max.-Signal DC Plate Current	500	500	500	ma
Zero-Signal DC Grid-No.2 Current	0	0	0	ma
Max.-Signal DC Grid-No.2 Current (Approx.)	10	8	8	ma
Effective Load Resistance (Plate to plate)	3300	6000	8700	ohms
Max.-Signal Driving Power (Approx.)	0	0	0	watts
Max.-Signal Power Output (Approx.)	220	400	590	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance (Per tube). 0.1 max. megohm

RF POWER AMPLIFIER—Class B Television Service

Synchronizing-level conditions per tube unless otherwise specified

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

	54 to 216 Mc	
DC PLATE VOLTAGE	2000 max.	volts
DC GRID-No.2 VOLTAGE	400 max.	volts
DC GRID-No.1 VOLTAGE	-250 max.	volts
DC PLATE CURRENT (Average)⊕	250 max.	ma
PLATE DISSIPATION	250 max.	watts
GRID-No.2 DISSIPATION	12 max.	watts
GRID-No.1 DISSIPATION	2 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	150 max.	volts
Heater positive with respect to cathode	150 max.	volts

Typical CCS Operation with Bandwidth of 5 Mc:

DC Plate Voltage	1000	1500	2000	volts
DC Grid-No.2 Voltage	350	350	350	volts
DC Grid-No.1 Voltage	-60	-65	-70	volts
Peak RF Grid-No.1 Voltage:				
Synchronizing level	65	71	76	volts
Pedestal level	52	57	62	volts
DC Plate Current:				
Synchronizing level	355	360	360	ma
Pedestal level	250	250	250	ma
DC Grid-No.2 Current:				
Synchronizing level	27	29	29	ma
Pedestal level	4	0	0	ma
DC Grid-No.1 Current:				
Synchronizing level	2	5	5	ma
Pedestal level	0	0	0	ma
Driving Power (Approx.):♦				
Synchronizing level	0.4	1.2	1.2	watts
Pedestal level	0	0	0	watts
Power Output (Approx.):				
Synchronizing level	160	300	440	watts
Pedestal level	90	170	250	watts

LINEAR RF POWER AMPLIFIER
Single-Sideband Suppressed-Carrier Service

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

	Up to 500 Mc	
DC PLATE VOLTAGE	2000 max.	volts
DC GRID-No.2 VOLTAGE	400 max.	volts
MAX.-SIGNAL DC PLATE CURRENT	250 max.	ma
PLATE DISSIPATION	250 max.	watts
GRID-No.2 DISSIPATION	12 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	150 max.	volts
Heater positive with respect to cathode	150 max.	volts

Typical CCS Class AB_1♦ "Single-Tone" Operation up to 175 Mc:♦♦

DC Plate Voltage	1000	1500	2000	volts
DC Grid-No.2 Voltage‡	350	350	350	volts
DC Grid-No.1 Voltage	-55	-55	-55	volts
Zero-Signal DC Plate Current	83	83	83	ma
Zero-Signal DC Grid-No.2 Current	0	0	0	ma
Effective RF Load Resistance	1650	3000	4350	ohms
Max.-Signal DC Plate Current	250	250	250	ma
Max.-Signal DC Grid-No.2 Current	5	4	4	ma
Max.-Signal Peak RF Grid-No.1 Voltage	47	47	47	volts
Max.-Signal Driving Power (Approx.)	0	0	0	watts
Max.-Signal Power Output (Approx.)	110	200	295	watts

Typical CCS Operation with "Two-Tone Modulation" at 30 Mc:☐☐

DC Plate Voltage	1000	1500	2000	volts
DC Grid-No.2 Voltage‡	350	350	350	volts
DC Grid-No.1 Voltage**	-55	-55	-55	volts
Zero-Signal DC Plate Current	83	83	83	ma
Effective RF Load Resistance	1650	3000	4350	ohms
DC Plate Current at Peak of Envelope	250	250	250	ma
Average DC Plate Current	175	175	175	ma
DC Grid-No.2 Current at Peak of Envelope	30	30	30	ma
Average DC Grid-No.2 Current	6	9.5	15	ma
Average DC Grid-No.1 Current	0	0	0	ma
Peak-Envelope Driver Power (Approx.)	1	1	1	watt
Output-Circuit Efficiency (Approx.)	95	95	95	%
Distortion Products Level:⊕				
Third Order	29	29	30	db
Fifth Order	40	38	35	db
Useful Power Output (Approx.):♠				
Average	55	100	147.5	watts
Peak Envelope	110	200	295	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Condition:

With fixed bias	25000 max.	ohms
With cathode bias	Not recommended	

PLATE-MODULATED RF POWER AMP.—Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

	Up to 500 Mc	
DC PLATE VOLTAGE	1500 max.	volts
DC GRID-No.2 VOLTAGE	300 max.	volts
DC GRID-No.1 VOLTAGE	-250 max.	volts
DC PLATE CURRENT	200 max.	ma

PLATE DISSIPATION.	165 max.	watts
GRID-No.2 DISSIPATION.	8 max.	watts
GRID-No.1 DISSIPATION.	2 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	150 max.	volts
Heater positive with respect to cathode	150 max.	volts

Typical CCS Operation at Frequencies up to 175 Mc:

DC Plate Voltage	500	1000	1500	volts
DC Grid-No.2 Voltage (Modulated approx. 55%)▲.	250	250	250	volts
DC Grid-No.1 Voltage★.	-100	-100	-100	volts
Peak RF Grid-No.1 Voltage. . . .	113	113	113	volts
DC Plate Current	200	200	200	ma
DC Grid-No.2 Current	32	31	31	ma
DC Grid-No.1 Current (Approx.) .	6	6	6	ma
Driving Power (Approx.)♦	0.7	0.7	0.7	watt
Power Output (Approx.)	50	140	235	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Condition.	25000 max.	ohms

RF POWER AMPLIFIER & OSC.—Class C Telegraphy† and RF POWER AMPLIFIER—Class C FM Telephony

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

	Up to 500 Mc	
DC PLATE VOLTAGE	2000 max.	volts
DC GRID-No.2 VOLTAGE	300 max.	volts
DC GRID-No.1 VOLTAGE	-250 max.	volts
DC PLATE CURRENT	250 max.	ma
PLATE DISSIPATION.	250 max.	watts
GRID-No.2 DISSIPATION.	12 max.	watts
GRID-No.1 DISSIPATION.	2 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	150 max.	volts
Heater positive with respect to cathode	150 max.	volts

Typical CCS Operation at Frequencies up to 175 Mc:

DC Plate Voltage	500	1000	1500	2000	volts
DC Grid-No.2 Voltage . . .	250	250	250	250	volts
DC Grid-No.1 Voltage . . .	-90	-90	-90	-90	volts
Peak RF Grid-No.1 Voltage.	109	109	109	109	volts
DC Plate Current	250	250	250	250	ma
DC Grid-No.2 Current . . .	48	45	36	30	ma
DC Grid-No.1 Current (Approx.).	12	12	11	11	ma
Driving Power (Approx.). .	1	1	1	1	watt
Power Output (Approx.) . .	65	180	290	400	watts

Typical CCS Operation at Frequency of 500 Mc with Coaxial Cavity:

DC Plate Voltage.	2000	volts
DC Grid-No.2 Voltage.	300	volts
DC Grid-No.1 Voltage.	-90	volts
DC Plate Current.	250	ma
DC Grid-No.2 Current.	10	ma
DC Grid-No.1 Current (Approx.).	25	ma
Driver Power Output (Approx.)●.	18	watts
Useful Power Output (Approx.)	250	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Condition	25000 max.	ohms

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Heater Current:				
Type 7203.	1	2.3	2.9	amp
Type 7204.	2	0.50	0.62	amp
Direct Interelectrode Capacitances (Types 7203 & 7204):□				
Grid No.1 to plate	-	-	0.06	μμf
Grid No.1 to cathode, grid No.2, and heater. .	-	14.2	17.2	μμf
Plate to cathode, grid No.2, and heater. .	-	4.0	4.8	μμf
Grid-No.1 Voltage:				
Type 7203.	1,3,7,8	-32	-46	volts
Type 7204.	2,3,7,8			
Grid-No.2 Current:				
Type 7203.	1,3,7,8	-7	+3	ma
Type 7204.	2,3,7,8			
Useful Power Output:				
Type 7203.	5,7,8	225	-	watts
Type 7204.	6,7,8			

Note 1: With 6.0 volts on heater.

Note 2: With 26.5 volts on heater.

Note 3: With dc plate voltage of 1000 volts, dc grid-No.2 voltage of 300 volts, and grid-No.1 voltage adjusted to give plate current of 150 ma.

Note 4: With plate floating, dc grid-No.2 voltage of 300 volts, and grid-No.1 voltage adjusted to give grid-No.2 current of 50 ma.

Note 5: With heater voltage of 5.5 volts, dc plate voltage of 2000 volts, dc grid-No.2 voltage of 300 volts, dc grid-No.1 bias of -90 volts, dc grid-No.1 current of 25 ma maximum, grid-No.1 signal voltage adjusted to produce dc plate current of 250 ma, and coaxial-cavity amplifier circuit operating at a frequency of 475 Mc.

Note 6: Same as Note 5 except heater voltage is 24.3 volts.

Note 7: With Forced-Air Cooling as specified under GENERAL DATA—*Air-System Socket.*

Note 8: Heater voltage must be applied for at least 30 seconds before application of other voltages.

SPECIAL PERFORMANCE DATA

Interelectrode Leakage:

This test is destructive and is performed on a sample lot of tubes from each production run under the following conditions: ac heater volts = 6.6 for type 7203 or 29.1 for type 7204, no voltage on other elements, and specified forced-air cooling for *Air-System Socket.* At the end of 500 hours, with tube at 25° C, and with no voltage applied to heater, the minimum resistance between indicated electrodes as measured with a 500-volt Megger-type ohmmeter having an internal impedance of 2.5 megohms, will be:

Grid No.1 and Grid No.2.	10 min.	megohms
Grid No.1 and Cathode.	10 min.	megohms
Grid No.2 and Cathode.	10 min.	megohms

§ Because the cathode is subjected to considerable back bombardment as the frequency is increased with resultant increase in temperature, the heater voltage should be reduced depending on operating conditions and frequency to prevent overheating the cathode and resultant short life.

□ With cylindrical shield JEDEC No.320 surrounding radiator; and with a cylindrical shield JEDEC No.321 surrounding the grid-No.2 ring terminal. Both shields are connected to ground.

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

♦ Subscript 1 indicates that grid-No.1 current does not flow during any part of the input cycle.

● Continuous Commercial Service.

* Averaged over any audio-frequency cycle of sine-wave form.

⊕ Averaged over any frame.

♠ The driver stage is required to supply tube losses and rf circuit losses. The driver stage should be designed to provide an excess of power above the indicated values to take care of variations in line voltage, in components, in initial tube characteristics, and in tube characteristics during life.

♠♠ "Single-Tone" operation refers to that class of amplifier service in which the grid-No.1 input consists of a monofrequency rf signal having constant amplitude. This signal is produced in a single-sideband suppressed-carrier system when a single audio frequency of constant amplitude is applied to the input of the system.

‡ Preferably obtained from a fixed supply.

□□ "Two-Tone Modulation" operation refers to that class of amplifier service in which the input consists of two equal monofrequency rf signals having constant amplitude. These signals are produced in a single-sideband suppressed-carrier system when two equal-and-constant-amplitude audio frequencies are applied to the input of the system.

** Obtained from a fixed supply.

♧ Without the use of feedback to enhance linearity.

♠ Measured at load of output circuit having indicated efficiency.

▲ The dc grid-No.2 voltage must be modulated approximately 55% in phase with the plate modulation in order to obtain 100% modulation of the 7203. The use of a series grid-No.2 resistor or reactor may not give satisfactory performance and is therefore not recommended.

★ Obtained from grid-No.1 resistor or from a combination of grid-No.1 resistor with either fixed supply or cathode resistor.

† Key-down conditions per tube without amplitude modulation. Amplitude modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

OPERATING CONSIDERATIONS

The *maximum temperatures* in the tabulated data for the base seals, grid-No.2 seal, plate seal, and plate are tube ratings and are to be observed in the same manner as other tube ratings. The temperature of the respective seals and of the plate may conveniently be measured with temperature-sensitive paint, such as Tempilaq. The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, N.Y. in the form of liquid and stick.

The *socket* for the 7203 should be of a type (such as is indicated in the tabulated data) which permits adequate air-cooling of the tube. Although the base will fit a conventional lock-in socket, the latter does not permit adequate cooling and its use is therefore not recommended.

The *plate connection* is made by means of a metal band or spring contacts to the cylindrical surface of the radiator. It is essential that the contact areas be kept clean to minimize rf losses especially at the higher frequencies.

The rated plate and grid-No.2 voltages of this tube are extremely dangerous to the user. Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel can not possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

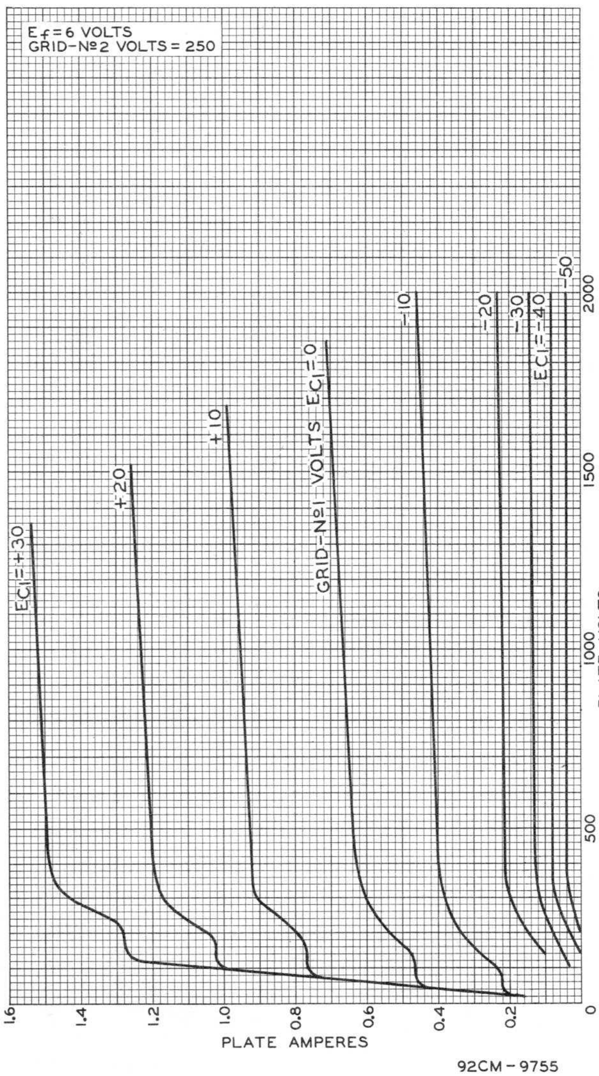


Fig. 1 - Typical Plate Characteristics of Type 7203.

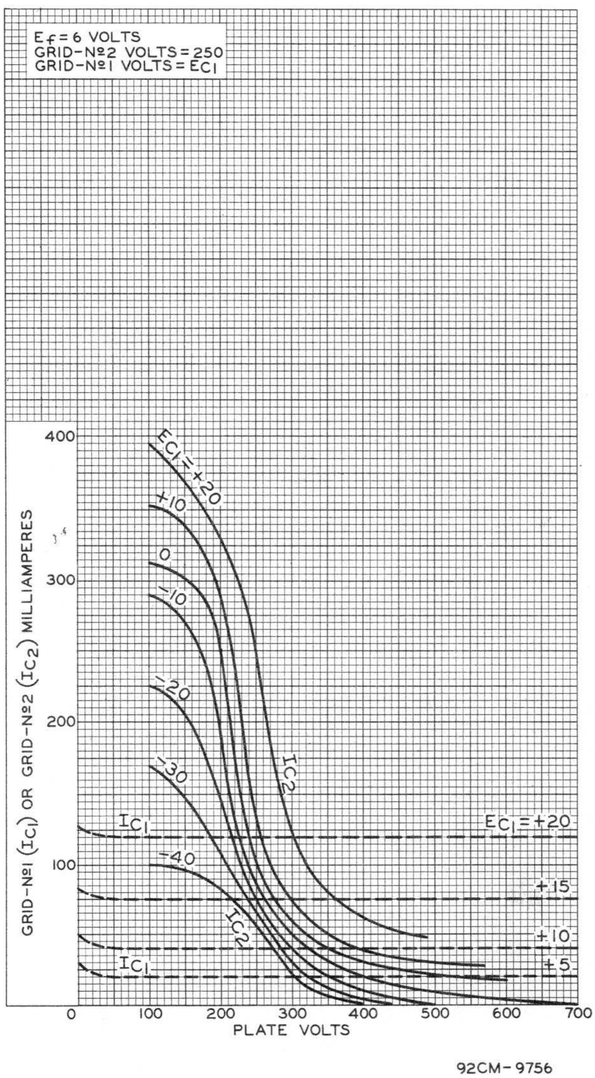


Fig. 2 - Typical Characteristics of Type 7203.

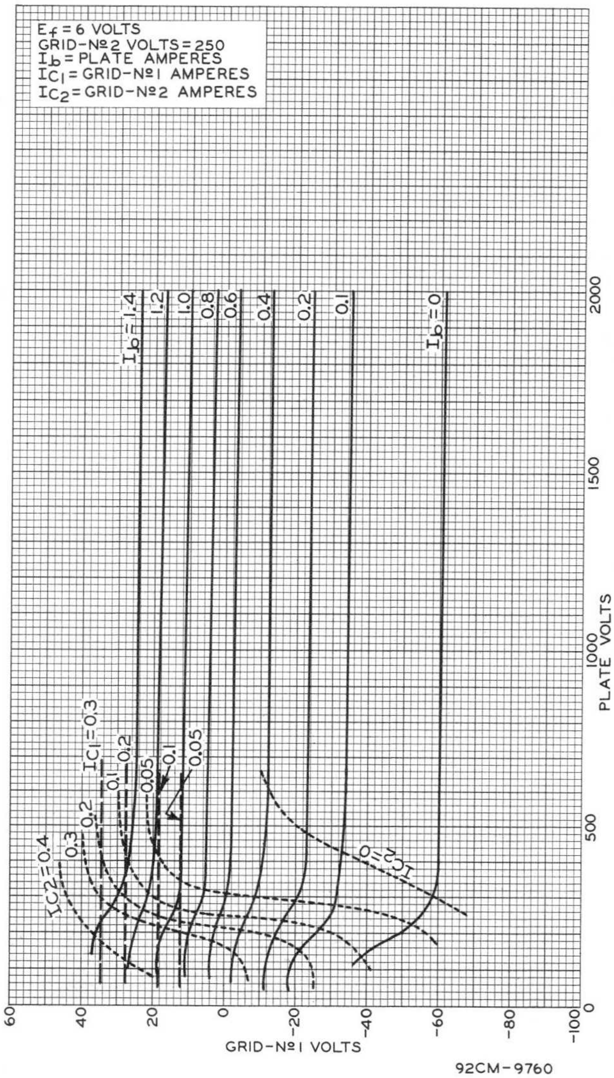


Fig. 3 - Typical Constant-Current Characteristics of Type 7203.

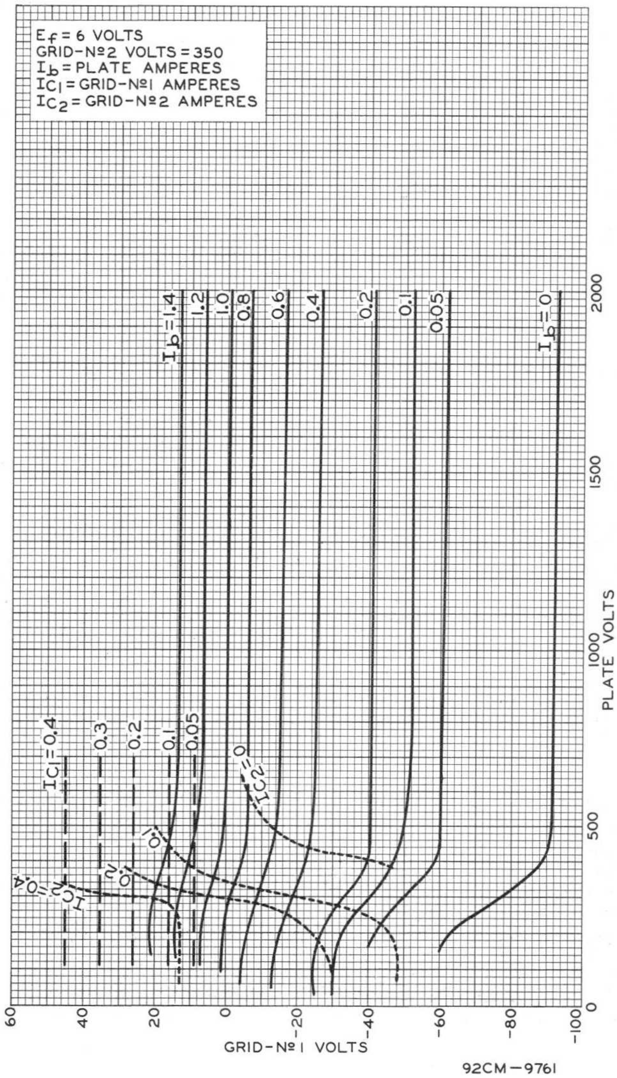
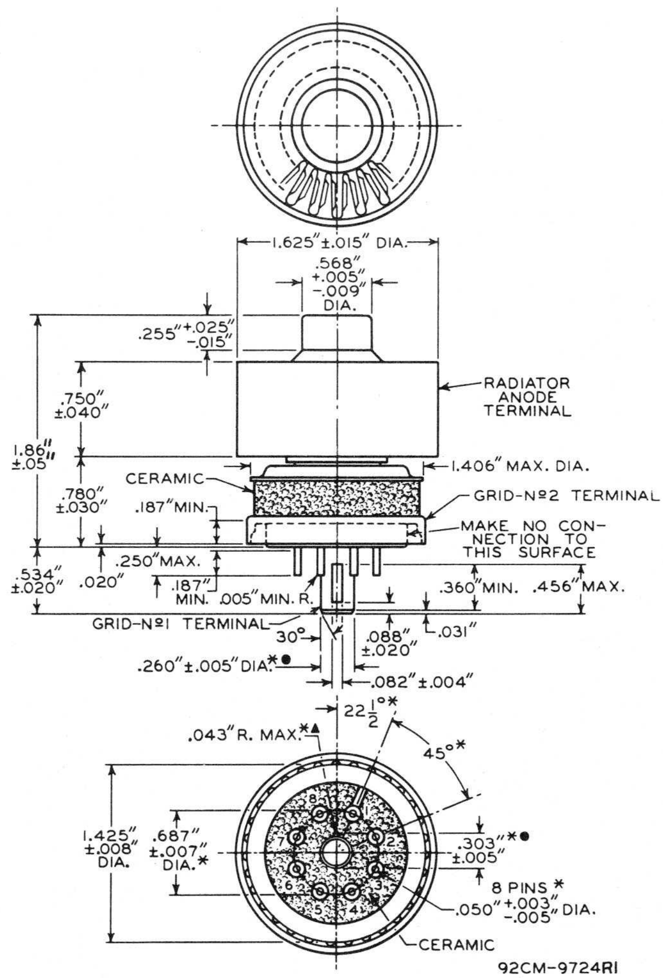


Fig. 4 - Typical Constant-Current Characteristics of Type 7203.

DIMENSIONAL OUTLINE



GRID-No.1 PLUG DIMENSIONS ARE MEASURED BY THE USE OF THE SERIES OF GAUGES SHOWN IN SKETCHES G_1 AND G_2. IN THE FOLLOWING INSTRUCTIONS FOR THE USE OF THESE GAUGES, "GO" INDICATES THAT THE ENTIRE GRID-No.1 PLUG KEY WILL ENTER THE GAUGE; AND "NO-GO" INDICATES THAT THE GRID-No.1 PLUG KEY WILL NOT ENTER THE GAUGE MORE THAN 1/16". INSTRUCTIONS FOR THE USE OF THE GAUGES FOLLOW:

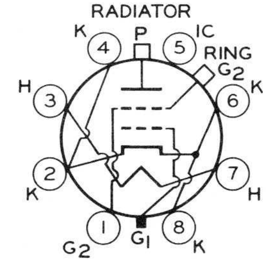
▲ GAUGES G_1-1, G_1-2, G_1-3, AND G_1-4:
USING ONLY SLOT C, TRY THESE GAUGES IN NUMERICAL ORDER UNTIL ONE IS FOUND THAT WILL ACCEPT THE ENTIRE GRID-No.1 PLUG. USING THE FIRST GAUGE THUS FOUND, IT WILL NOT BE POSSIBLE TO INSERT THE GRID-No.1 PLUG IN SLOT B.

● GAUGES G_2-1, G_2-2, AND G_2-3:
THE GRID-No.1 PLUG WILL BE REJECTED BY GAUGES G_2-1 AND G_2-2, BUT WILL BE ACCEPTED BY GAUGE G_2-3.

* BASE-PIN POSITIONS ARE HELD TO TOLERANCES SUCH THAT THE ENTIRE LENGTH OF THE PINS WILL, WITHOUT UNDUE FORCE, PASS INTO AND DISENGAGE FROM THE FLAT-PLATE GAUGE SHOWN IN SKETCH G_3.

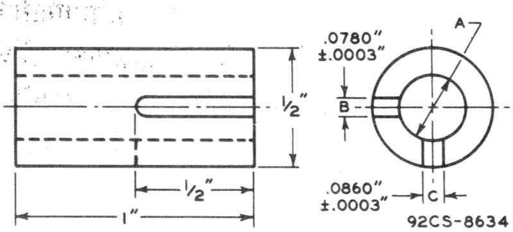
BASING DIAGRAM
Bottom View

PIN 1: GRID No.2 (For use at the lower frequencies)
PIN 2: CATHODE
PIN 3: HEATER
PIN 4: CATHODE
PIN 5: INTERNAL CONNECTION-- DO NOT USE
PIN 6: CATHODE



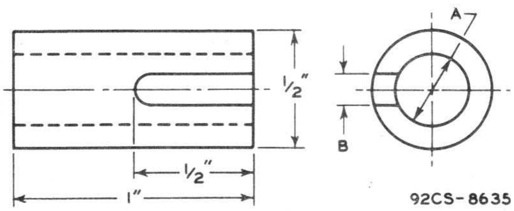
PIN 7: HEATER
PIN 8: CATHODE
BASE INDEX PLUG: GRID No.1
RADIATOR: PLATE
RING TERMINAL: GRID No.2 (For use at the higher frequencies)

Gauge Sketch G_1



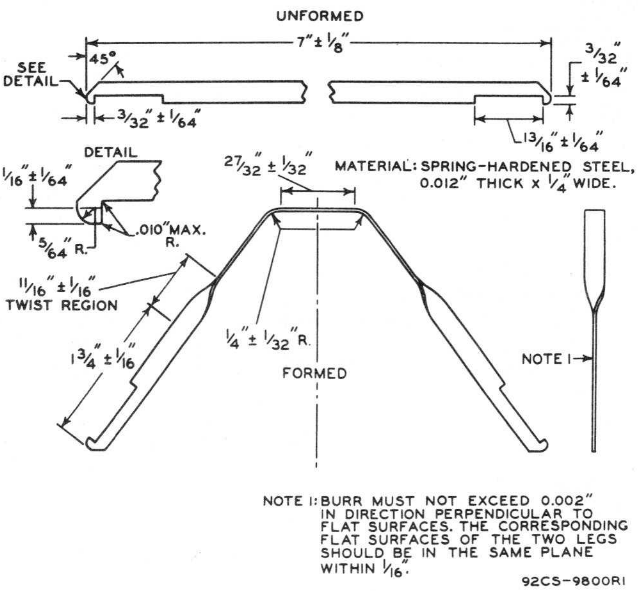
Gauge	Dimension A
G_1 – 1	.2575" + .0000" – .0005"
G_1 – 2	.2600" + .0000" – .0005"
G_1 – 3	.2625" + .0000" – .0005"
G_1 – 4	.2650" + .0000" – .0005"

Gauge Sketch G_2

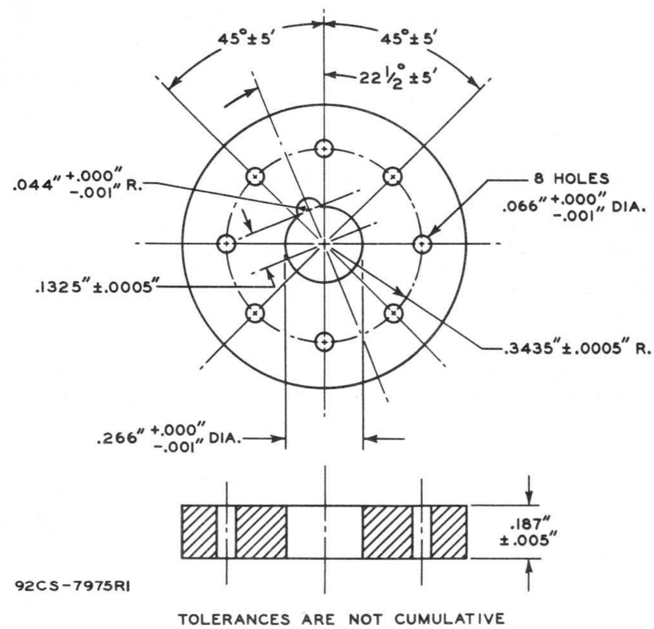


Gauge	Dimension A	Dimension B
G_2 – 1	.2550" + .0000" – .0005"	.125"
G_2 – 2	.2980" + .0000" – .0005"	none
G_2 – 3	.3080" + .0000" – .0005"	none

Suggested Design for Extractor to Remove Tube from Cavity



Gauge Sketch G_3



This bulletin is to be used in conjunction with the publication 1CE-277 "RCA Display-Storage Tubes".

RCA-7268A
DISPLAY-STORAGE TUBE

High Resolution Type For Use Under Severe Environmental Conditions, 4"-Diameter Display, Two Writing Guns, One Viewing Gun, Integral Magnetic Shield

The 7268A is unilaterally interchangeable with type 7268

RCA-7268A is a "ruggedized", 5" -diameter, direct-view electrostatic focus and deflection type of display-storage tube designed for use in military and commercial information-handling displays where rough tube usage may be encountered. It has two writing guns which permit the simultaneous writing of two independent signals and a single viewing gun.

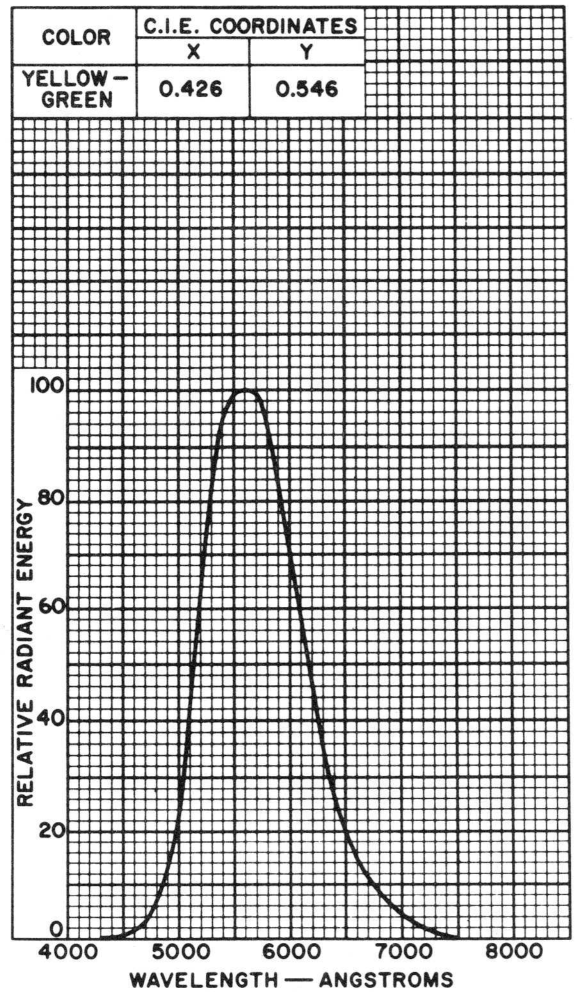
The 7268A is capable of providing a non-flickering 4"-diameter display having uniform brightness and excellent positional accuracy of written signals under environmental conditions involving severe vibration, extremes in temperature and pressure, salt spray, and high humidity.

Its rugged internal structure, high brightness, and an adjustable rate of information decay make the 7268A especially useful, under daylight viewing conditions, in airborne fire-control radar systems.

FEATURES

- Excellent Resolution
  –70 lines per inch (min.)
- High Display Brightness
  –2500 footlamberts (typical)
- High Display Accuracy
- Two Writing Guns Having Close Registration Capability
- Designed to Withstand the Severe Environmental Requirements of Airborne Equipment
- Integral Magnetic Shield
- Ability to Integrate Signals in Presence of Noise

SPECTRAL-ENERGY EMISSION CHARACTERISTIC OF PHOSPHOR P20



DATA

Electrical:

Heater, for Unipotential Cathode (All guns):

Voltage (AC or DC)	6.3 ± 10%	volts
Current at 6.3 volts	0.6	A
Cathode Heating Time (Minimum) before other electrode voltages are applied	30	sec

Writing Section – Each Gun:

Focusing Method	Electrostatic
Deflection Method	Electrostatic
Deflecting-Electrode Arrangement	*See Dimensional Outline*

Direct Interelectrode Capacitances:

Grid No.1 to all other electrodes	15 max.	pF
Cathode to all other electrodes	8 max.	pF
Deflecting electrode DJ1 to deflecting electrode DJ2	3 max.	pF
Deflecting electrode DJ3 to deflecting electrode DJ4	2 max.	pF
DJ1 to all other electrodes	10 max.	pF
DJ2 to all other electrodes	10 max.	pF
DJ3 to all other electrodes	10 max.	pF
DJ4 to all other electrodes	10 max.	pF

Viewing Section:

Direct Interelectrode Capacitances:

Grid No.1 to all other electrodes	18 max.	pF
Cathode to all other electrodes	10 max.	pF
Backplate to all other electrodes	110 max.	pF

Optical:

Phosphor . . . . P20, Aluminized

Mechanical:

Minimum Useful Viewing Diameter	4"
Maximum Overall Length	16"
Maximum Diameter (Excluding screen lead)	5.28"
Screen Connector Assembly	*See Dimensional Outline*
Base	JEDEC No.B25-216

Bulb Terminals:

Caps (Three)	Recessed Small Ball (JEDEC No.J1-22)
Operating Position	Any
Weight	5-1/4 lbs

Maximum and Minimum Ratings, *Absolute-Maximum Values:*[a]

All voltages are shown with respect to the cathode of the viewing gun unless otherwise specified.

	Min.	*Max.*	
Screen Voltage:			
Peak	-	11500	volts
DC	0	11000	volts
DC Backplate Voltage	0	35	volts
Collector (Viewing-Grid-No.4) Voltage[b]	0	300	volts
Collimator (Viewing-Grid-No.3) Voltage[b]	0	300	volts
Viewing-Grid-No.2, Writing-Grid-No.4, and Writing-Grid-No.2 Voltage[bc]	0	200	volts
Viewing-Grid-No.1 Voltage[b]	-150	0	volts
Viewing-Gun Heater-To-Cathode Voltage	-125	125	volts
Magnetic Shield Voltage	-200	200	volts
Writing-Grid-No.4, Writing-Grid-No.2-To-Any Deflecting Electrode Voltage (Each Gun)[c]	-500	500	volts
Writing-Grid-No.3 Voltage (Each Gun)[d]	0	2000	volts
Writing-Grid-No.1 Voltage (Each Gun)[d]	-200	(e)	volts
Writing-Gun Cathode Voltage (Each Gun)	-2800	0	volts
Writing-Gun Heater-To-Cathode Voltage (Each Gun)	-125	125	volts
Series Current-Limiting Resistor (Unbypassed) in Screen Circuit	1	-	megohm
Series Current-Limiting Resistor (Unbypassed) in Viewing-Grid-No.4 Circuit	0.005	-	megohm

Recommended Operating Values:

All voltages are shown with respect to the cathode of the viewing gun unless otherwise specified.

Screen Voltage	10000	volts
Backplate Voltage[f]	2	volts
Collector (Viewing-Grid-No.4) Voltage	265	volts
Collimator (Viewing-Grid-No.3) Voltage[g]	50 to 125	volts
Viewing-Grid-No.2 Voltage[b]	100	volts
Viewing-Grid-No.1 Voltage[g]	-50 to 0	volts
Writing-Grid-No.3 Voltage (Each Gun)[h]	-2325 to -1975	volts
Writing-Grid-No.1 Voltage (Each Gun)	(ej)	volts
Writing-Gun Cathode Voltage	-2400	volts
Magnetic Shield Voltage	0	volts
Average Deflecting Plate Voltage[k]	100	volts
Circuit Values:		
Grid-No.1 Circuit Resistance (Either Gun)	1 max.	megohm
Impedance in Any Deflecting Electrode Circuit[m]	0.01 max.	megohm
Backplate-Circuit Resistance	0.005 max.	megohm
Series Current-Limiting Resistor (Unbypassed) in Screen Circuit	1	megohm
Series Current-Limiting Resistor (Unbypassed) in Collector (Viewing-Grid-No.4) Circuit	0.010	megohm

Characteristics:

	Min.	*Typ.*	*Max.*	
Useful Viewing Diameter	4	-	-	inches
Brightness (Luminance)[n]	-	2500	-	footlamberts
Viewing Duration[p]	15	-	-	seconds
Erase Time[q]	-	28	-	milliseconds
Resolution[r]	70	-	-	lines/in.
Undeflected Spot Position	-	-	(s)	millimeters
Deflection Factors:				
DJ1 & DJ2	82	-	100	volts/inch
DJ3 & DJ4	82	-	100	volts/inch

Performance Data:

Writing Ability and *Writing Uniformity* characteristics are measured singly for both guns. A 3.5" x 3.5" raster is centered on the tube face. Vertical scanning is accomplished by an interrupted linear sawtooth waveform having a scan time of 625 microseconds and a prf of 500 pps. Horizontal scanning is provided by a triangular waveform having a scan rate of 3.5 inches per second.

Writing Ability. The writing-gun grid No.1 of the gun under test is driven above cutoff during the vertical scan time by white noise, of approximately 5 megacycle bandwidth, having a zero-to-peak amplitude of approximately 35 volts. The display brightness under these conditions shall be at least 20% of saturated brightness.

Writing Uniformity. This characteristic is determined under the same conditions as specified above except that the rms amplitude of the white noise is adjusted to produce brightness of 40% of saturated brightness at the dimmest area in the display. The measured brightness at the brightest area of the display shall be not more than 80% of saturated brightness.

Environmental Tests:

The 7268A is designed to withstand the following operational and non-operational environmental tests.

Operational Tests:

Sinusoidal Vibration. This test consists of tube vibration in each of three orthogonal axes. One of these axes is in the plane passing through the major axis of the tube and the center of the tube-base key. The tube is mounted so that its major axis is parallel to the plane of the earth. A total of 6 cycles of swept sinusoidal vibration, from 10 to 500 and back to 10 cycles per second, is performed. The duration of a sweep cycle is 15 minutes. The frequencies of any resonant points are noted. The sinusoidal vibration schedule is shown below.

Double Amplitude inches	Peak Acceleration g's	Sweep Frequency c/s	Sweep Cycle Duration minutes
0.27	-	10 to 20	
-	4	20 to 46	
-	2	46 to 500	15
-	2	500 to 46	
-	4	46 to 20	
0.27	-	20 to 10	

Vibration at Resonance. This test consists of tube vibration at the resonant point or points determined in *Sinusoidal Vibration* for a period of 30 minutes. If more than one resonant point is noted for a given axis, the tube is vibrated for a total of 30 minutes at that resonant point in each axis most likely to produce tube failure. If no resonant points are determined in *Sinusoidal Vibration,* the tube is vibrated for 60 minutes at a frequency of 55 cycles per second.

Low Pressure - High Temperature. This test consists of tube storage for a period of not less than one hour at a temperature of +100° C. At the termination of this storage period, the tube is operated with the values shown under *Recommended Operating Values* applied and at a pressure equivalent to an altitude of 32,000 feet. The temperature is then reduced to +53° C. The tube is stored at this temperature for 1 hour and then is operated with normal voltages applied at a pressure equivalent to an altitude of 60,000 feet.

Low Temperature. This test consists of the tube being maintained at a temperature of -65° C for 48 hours. At the end of this period and while the tube is still at -65° C, the tube is operated with recommended voltages applied for 15 minutes.

Non-Operational Tests:

Temperature Cycling. This test consists of tube storage for a period of not less than 2 hours at a temperature of -65° C followed within 5 minutes by storage for a period of 2 hours at a temperature of +100° C. A minimum of five consecutive cycles are performed.

High Pressure. This test consists of tube exposure to an absolute pressure of 45 pounds per square inch for a period of at least 60 seconds. This pressure shall be attained within 60 seconds.

Torque. This test consists of the application of a torque of 40 inch-pounds between the integral magnetic shield and the tube base.

Salt Spray. This test consists of tube exposure to a fine spray from a salt solution for a period of 48 hours. The ambient temperature is maintained at approximately 35° C.

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[a]The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[b]These voltages should never be adjusted to values which will permit the display of a sharply-defined circular area of brightness having a diameter of less than 3.5 inches. See *Operating Procedure* for the proper set-up to follow.

[c]Grids No.4 and No.2 of writing gun and the grid No.2 of viewing gun are connected within the tube.

[d]Voltages are shown with respect to cathode of writing gun.

[e]The writing-gun grid No.1 should never be more positive than necessary to write the display to saturated brightness for a given scanning and drive condition. In no case should the writing-gun grid-No.1 voltage have a value greater than zero with respect to the writing-gun cathode.

[f]The backplate should be maintained at 2 volts between erasing pulses when dynamic erasure is employed.

[g]Adjusted for brightest, most uniform, full-size pattern.

[h]Adjusted for the smallest, most circular spot.

[i]The bias-voltage value for writing-beam cutoff is between -60 and -100 volts with respect to writing-gun cathode.

[k]With respect to the viewing-gun cathode for each pair of deflecting electrodes.

[m]Recommended value for minimum distortion because of viewing beam collection by the deflecting plates. Where strict display accuracy and display uniformity are not required, the impedance value for any deflecting-electrode circuit may be as high as 0.1 megohm maximum. For optimum performance, it is recommended that the deflecting-electrode-circuit impedances be approximately equal.

[n]Brightness (Luminance) is measured after the entire display is written to saturated brightness, the writing gun has been turned off, and with no erasing pulse applied.

[p]The time required for any 0.5-inch diameter area of the 4"-diameter viewing area to rise spontaneously (with no writing or erasing) from zero brightness (viewing-beam visual cutoff) to 10% of saturated brightness.

[q]With the display at saturated brightness, a series of rectangular pulses 5 milliseconds in width and at a repetition frequency of 2 pps is applied to the backplate. The number of pulses required to just erase completely the center of the display is noted. This number is multiplied by 5 milliseconds to obtain the erase time. The amplitude of the erase pulses is adjusted to obtain the minimum erase time.

[r]Measured by the "shrinking" raster method under conditions of continuous writing and erasing with erase pulses of 60 μsec width and a repetition frequency of 300 pps. The amplitude of the erase pulses is adjusted to provide 3.5-second erasure and grid No.1 is adjusted to provide 1000 foot-lamberts brightness of the just "shrunken" raster.

[s]The undeflected spot position must fall within a square having a 15 millimeter side (maximum) centered on the tube face and parallel to a trace produced by one set of deflecting plates.

OPERATING PROCEDURE

The following steps should be followed when the 7268A is first placed in operation. Refer to the precautions shown under *Operating Considerations* in the publication 1CE-277 "RCA Display-Storage Tubes". *Note that all electrode voltages are referred to the cathode of the viewing gun unless otherwise specified.*

1. *Viewing Gun*—Apply power to the heater of the viewing gun and allow 60 seconds for the cathode to reach normal operating temperature. Next apply the following voltages to the viewing-gun electrodes: zero volts to the viewing-gun cathode, zero volts to the viewing-gun grid No.1, +100 volts to the viewing-gun grid No.2, +125 volts to the collimator, +265 volts to the collector, +2 volts to the backplate, and +10,000

volts to the screen. Except for the application of screen voltage, which may be increased, at the user's option, from 0 volts to 10,000 volts slowly, all of the above voltage values should be applied to the tube simultaneously and without first passing through intermediate voltage values. Next apply dynamic erasing pulses to the backplate. Adjust the viewing-gun grid-No.1 voltage to a value midway between zero volts and that voltage at which the viewing diameter begins to decrease. Reduce the collimator voltage until the viewing diameter starts to decrease, and then increase the collimator voltage by 10 volts. The storage property of the tube can be observed by setting the amplitude of the dynamic erasing pulses at +12 volts for several seconds and by then reducing it to zero volts. As the erasing pulse amplitude is reduced the screen should go dark. The 7268A is now storing an overall "black picture" and stays in this condition until the screen begins to brighten as a result of the storage grid being gradually discharged by positive ions landing on it.

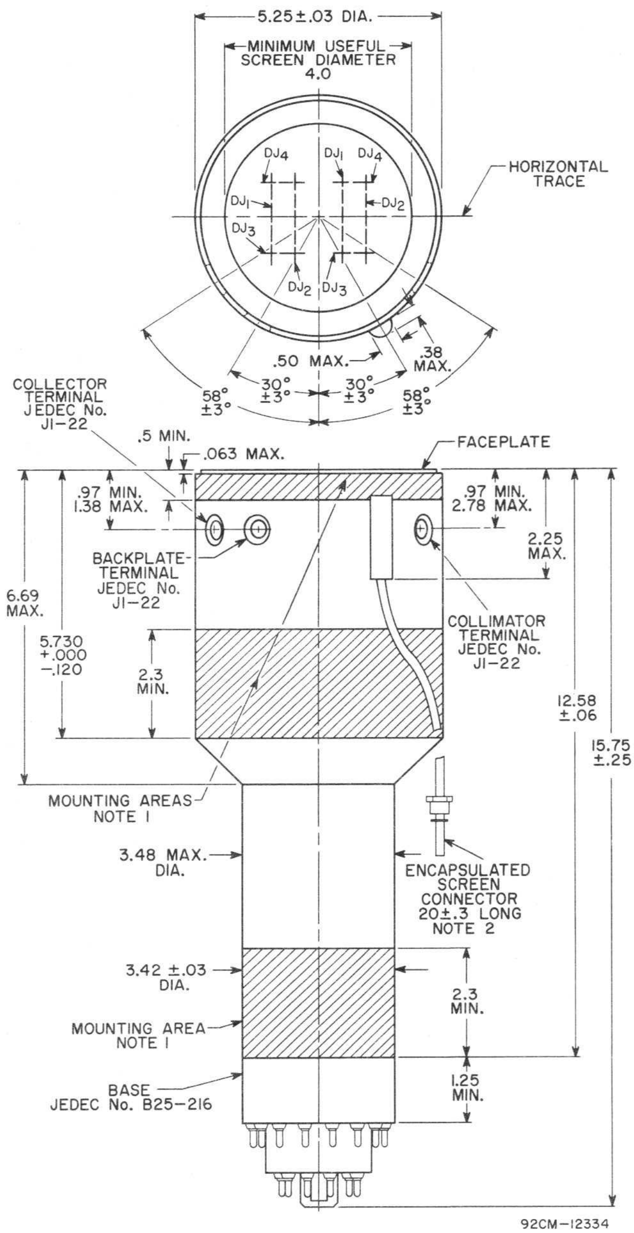
2. *Writing Gun*—Apply power to the heater of the writing gun and allow 60 seconds for the cathode to reach normal operating temperature. Then, with reference to the typical operating values shown in the tabulated data under *Recommended Operating Values,* set the grid-No.1 voltage to cutoff, and apply dc voltages to the electrodes of the writing gun. With the screen made dark by the charging method described under (1), the grid-No.1 bias is reduced until the writing beam is seen as a spot on the screen. If the beam is caused to move, either by centering adjustment or by application of deflection voltage, it should leave a bright trace. After an area has been written to full brightness, the writing-beam spot may be seen as a slightly brighter spot on the bright background. Writing-beam focus can then be optimized by adjusting the grid-No.3 voltage.

3. *Final Display Adjustments*—The dc bias and the video-signal amplitude applied to grid No.1 or cathode of the writing gun should be adjusted to set the black level and the highlight level in the display. These adjustments depend on the scanning rate used. Resolution decreases with increasing writing-gun beam current. Excessive writing-gun beam current will produce screen saturation and any further beam-current increase will not produce additional highlight brightness and may also decrease half-tone rendition. It is recommended that the writing-beam current always be adjusted to a minimum value to produce the best display without saturation of highlight brightness. The dynamic erasing-pulse amplitude and duty cycle should be adjusted in accordance with the information contained in 1CE-277. The collimator voltage should be adjusted for optimum display uniformity. If the collimator voltage is too high, the center area of the display will tend to erase slowly. If the collimator voltage is too low, the edges of the display will tend to erase slowly.

The following operating precautions must be followed to protect the 7268A from inadvertent damage—

1. Do not exceed maximum ratings.
2. Be sure to include the screen resistor.
3. Be sure to include the collector resistor.
4. Do not apply excessive writing-beam current density.
5. Protect against scanning failure.
6. Protect against loss of bias.
7. Apply voltages to tube in correct order.
8. Never write unless viewing beam is on.
9. Stay within recommended viewing-grid voltage ranges.

DIMENSIONAL OUTLINE



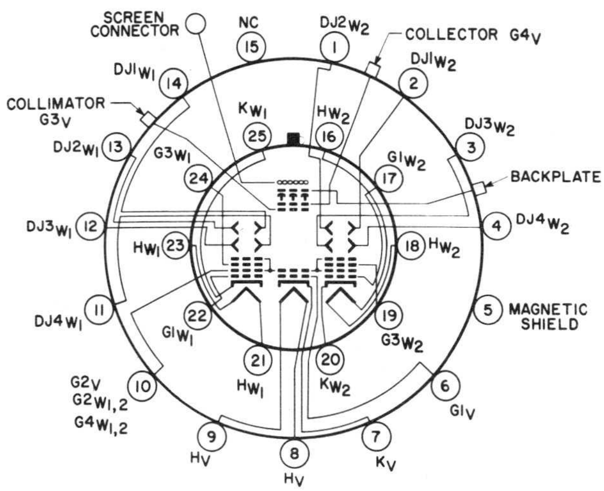
Dimensions in Inches

NOTE 1: The indicated areas are recommended for mounting purposes.

NOTE 2: Amp Part No. Amp 832 692-0; manufactured by Aircraft Marine Products, Inc., Harrisburg, Pa., or equivalent.

BASING DIAGRAM

Bottom View



Pin 1: Deflecting Electrode DJ2 of Writing Gun No.2

Pin 2: Deflecting Electrode DJ1 of Writing Gun No.2

Pin 3: Deflecting Electrode DJ3 of Writing Gun No.2

Pin 4: Deflecting Electrode DJ4 of Writing Gun No.2

Pin 5: Integral Magnetic Shield

Pin 6: Grid No.1 of Viewing Gun

Pin 7: Cathode of Viewing Gun

Pin 8: Heater of Viewing Gun

Pin 9: Heater of Viewing Gun

Pin 10: Grid No.2 of Viewing Gun, Grid No.2 and Grid No.4 of Writing Guns No.1 and No.2

Pin 11: Deflecting Electrode DJ4 of Writing Gun No.1

Pin 12: Deflecting Electrode DJ3 of Writing Gun No.1

Pin 13: Deflecting Electrode DJ2 of Writing Gun No.1

Pin 14: Deflecting Electrode DJ1 of Writing Gun No.1

Pin 15: NC – No Internal Connection

Pin 16: Heater of Writing Gun No.2

Pin 17: Grid No.1 of Writing Gun No.2

Pin 18: Heater of Writing Gun No.2

Pin 19: Grid No.3 of Writing Gun No.2

Pin 20: Cathode of Writing Gun No.2

Pin 21: Heater of Writing Gun No.1

Pin 22: Grid No.1 of Writing Gun No.1

Pin 23: Heater of Writing Gun No.1

Pin 24: Grid No.3 of Writing Gun No.1

Pin 25: Cathode of Writing Gun No.1

Flexible Lead: Screen (Encapsulated)

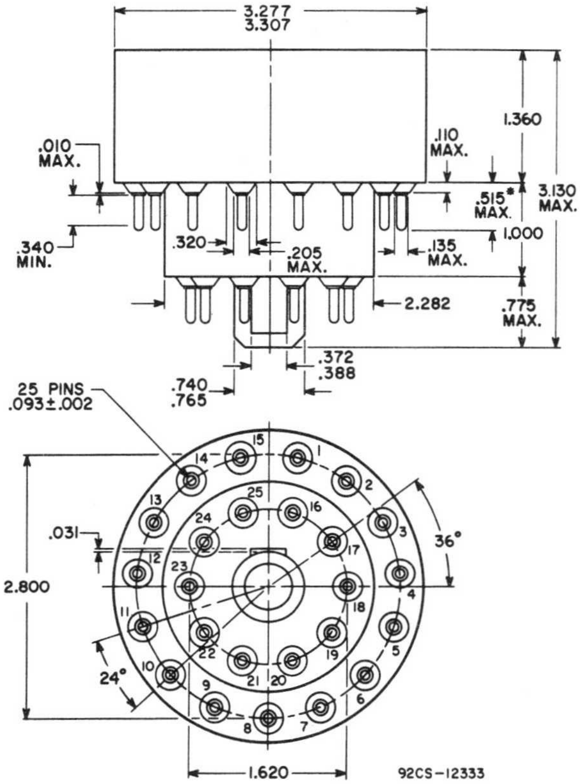
Recessed Small Ball Caps:

Over Pin No.3
Collimator (Viewing Grid No.3)

Over Pin No.13
Collector (Viewing Grid No.4)

Over Pin No.14
Backplate

BASE DRAWING
25-PIN BASE
JEDEC No.B25-216



Dimensions in Inches

* Add 0.030" for solder.

DISPLAY-STORAGE TUBES

Direct-View Types

Information shown on these pages is to be used in conjunction with RCA display-storage tube data.

RCA display-storage tubes of the direct-view type are used in applications that require a bright, non-flickering display of stored information containing half-tones for relatively long periods of time. They provide continuous displays having high contrast under conditions of high ambient light for many seconds after writing has ceased and integrate repetitive signals so that information can be distinguished from random noise. Typical applications using display-storage tubes include the following:

RADAR—*Ground, Airborne, and Marine*

- Fire control
- Search
- Weather
- Ground Mapping
- Proximity Warning
- Navigation

OTHER INFORMATION DISPLAYS

- Electronic Reconnaissance and Countermeasures
- Compressed Bandwidth Video Systems
- Oscillograph Displays of Non-recurrent Transients
- Sonar

The voltage and other values used in this publication do not apply to any particular display-storage tube type. Although these values may be typical, they are intended only to explain the principles of operation of the device. Refer to the data contained in the technical bulletin for a given tube type for specific ratings, operating values, and performance and characteristic values.

PRINCIPLES OF OPERATION

A schematic arrangement of a typical display-storage tube is shown in Fig. 1. The viewing electron gun produces a low-velocity, unfocused electron beam that continuously floods the target electrodes. The target electrodes consist of a phosphor screen (usually aluminized) on the inside surface of the faceplate, a backplate mesh covered with a thin layer of insulating material which serves as the storage grid, and a collector grid.

The writing gun (or guns) produces a well-defined high-velocity beam that is deflected, focused, and intensity modulated in the same manner as the beam of a cathode-ray tube.

The writing beam establishes a potential distribution on the storage grid which controls the viewing-beam current reaching the phosphor screen in the same manner as the grid voltage of a triode receiving tube controls its plate current, i.e., when the storage grid is established at negative voltages with respect to the viewing-gun cathode it can limit or cut off the viewing-beam current.

The tube may also contain a selective erasing gun which produces a low-velocity, focused beam that permits selective erasure of some areas of stored information on the storage grid without disturbing other areas.

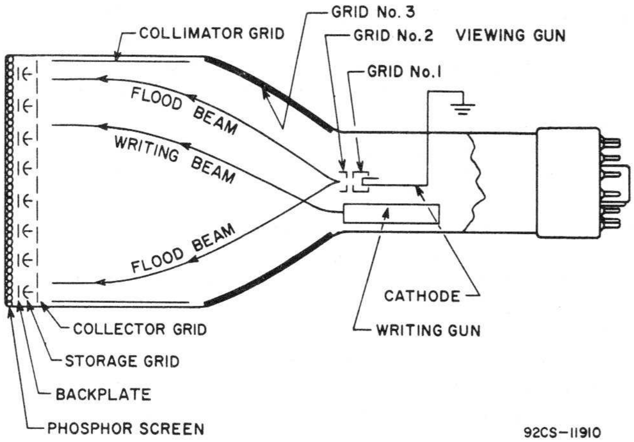


Fig. 1 - Schematic Arrangement of a Display-Storage Tube.

The operation of the display-storage tube may be described by separating it functionally into viewing, writing, and erasing operations.

The Viewing Operation

In addition to the viewing gun and the target elements, the viewing section contains additional electrodes for the collimation of the viewing beam.

The cathode, grid No. 1, and grid No. 2 of the viewing gun produce a high-density, low-velocity stream of electrons that is typically collimated (made parallel) and controlled in size by adjustment of grid-No. 1, grid-No. 3, and collimator-grid voltages. This collimated stream of electrons continuously floods the collector grid and the storage grid. Collimation is required so that the electrons, after passing through the collector grid, will approach all points on the storage grid in paths normal (perpendicular) to its surface. This normal approach of electrons having uniform velocity makes possible the uniform control of the electrons at every point on the storage grid.

Grid No.3 may be a conductive coating on the bulb-wall interior as shown in Fig.1. This figure also shows the location of the collimator grid which is often a metal cylinder that is mechanically supported by the target electrodes.

The collector grid is a fine metal mesh. It collects secondary electrons emitted from the storage grid during writing, and viewing-beam electrons turned back from the storage grid when the storage grid's potential is sufficiently negative. Also, because the collector grid is the most positive element thus far seen by the electron beams, it repels positive ions (produced by collision of electrons with residual gas molecules) and prevents ions in the region between the guns and the collector grid from landing on the storage grid and thus altering a stored charge pattern.

The storage grid consists of a very thin layer of material, having appropriate insulating and secondary-emission characteristics, that is deposited on the backplate, which is a fine metallic mesh. The deposit is on the gun side of the mesh, and leaves the size of the mesh openings essentially unchanged. In effect, the storage grid consists of a multiplicity of independent storage elements, each a capacitor. The thin layer of material of the storage grid serves as the dielectric, and its two surfaces serve as plates. One surface is in electrical contact with the backplate and the other surface faces the electron beams. The potential resulting from the charge stored in these individual capacitors determines the amount of viewing-beam current which reaches the corresponding areas of the phosphor screen, and therefore, controls the brightness of the display.

The backplate is ordinarily operated at a low positive potential (typically +2 volts) with respect to the viewing-gun cathode which is at ground potential. Assume the storage grid has the same potential as the backplate when the viewing section is initially placed in operation. The storage grid has this potential because the elemental capacitors are assumed to be discharged, i.e., there is no previously established charge pattern. Viewing-beam electrons passing through the collector grid are decelerated as they approach the storage grid, and because this grid is assumed initially to be +2 volts, it follows that they will land on its surface. Because of their low velocity, these electrons produce a secondary-emission ratio of less than unity and a net negative charge is deposited on the storage grid. As the negative charge builds up on the elemental capacitors, the potential of the storage grid drops. This process continues until the storage grid reaches an equilibrium value at viewing-gun cathode potential.

Under these conditions, a majority of the viewing-beam electrons passing through the collector grid are funneled through the storage-grid mesh openings to the phosphor screen and cause it to fluoresce over its entire area. In this condition, the brightness of the screen is designated as "saturated brightness".

Light output from the screen at saturated brightness varies with the voltage applied to the screen. As shown in Fig.2, the light output rises rapidly at screen voltages above a threshold of about 5000 volts for a display-storage tube having an aluminized screen. A display of high brightness is possible because each spot on the phosphor screen is continuously excited by the high-current viewing beam rather than intermittently excited as in conventional cathode-ray tubes. A high-current flooding-type viewing

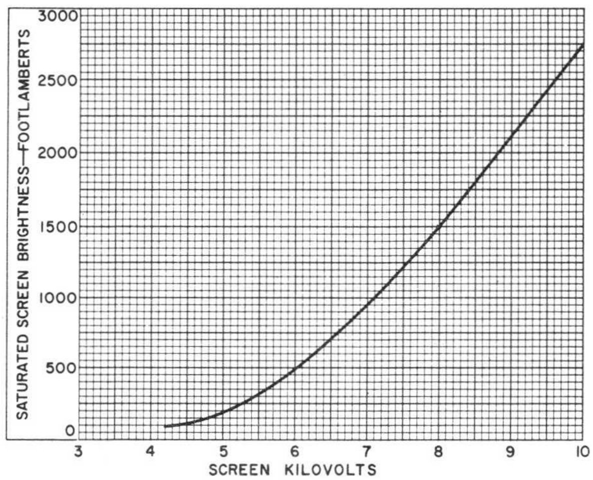


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Fig.2 - Typical Brightness Characteristic of a Display-Storage Tube Having an Aluminized Screen.

beam can be used because the display function (viewing) is separated from the information input function (writing) and consequently, external focusing, deflection, and modulation of the viewing beam are not required.

Assume that the entire storage grid has been uniformly charged to viewing-gun cathode (ground) potential and that the backplate is at +2 volts. The display is now at saturated brightness. The viewing beam may be cut off from the phosphor screen by making the storage grid sufficiently negative with respect to the viewing-gun cathode. This may be accomplished by shifting the backplate from its normal potential of +2 volts to a more positive potential, for example, +8 volts. Because of the capacitive coupling between the backplate and the storage grid, the storage grid rises an equal amount positive from its initial ground potential of zero volts to a potential of +6 volts. Viewing-beam electrons are now able to land on the storage grid and charge it in a negative direction. Charging continues until the storage-grid potential is reestablished at zero volts, while the backplate remains at +8 volts. Now, if the backplate potential is returned to its initial value of +2 volts, the storage-grid potential drops correspondingly to -6 volts, a voltage sufficient to assure cutoff. Electrons in the viewing beam are now turned back as they approach the storage grid and return to the collector. The phosphor screen is dark.

At values of storage-grid potential between those which produce viewing-beam cutoff and those which produce saturated brightness, the amount of viewing-beam current which penetrates the storage-grid openings, and hence the amount of light emitted by the screen, is a function of storage-grid potential. This effect is shown in Fig.3 for a typical display storage tube. For backplate voltages more positive than those assumed in Fig.3, this storage-grid characteristic tends to shift to the left. For phosphor-screen or collector-grid voltages less positive than those assumed in Fig.3, the characteristic tends to shift to the right and to exhibit more slope.

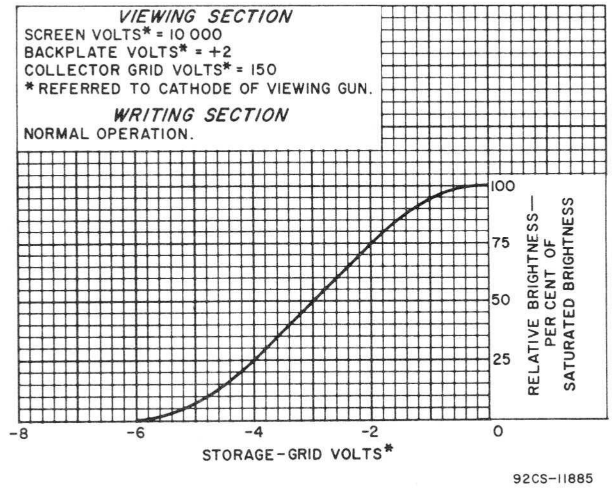

Fig. 3 - Typical Storage-Grid Characteristic of a Display-Storage Tube.

The Writing Operation

The writing gun of the display-storage tube is similar to that of a cathode-ray tube. Its beam may be focused, deflected, and modulated in the same manner as the beam in a cathode-ray tube. It is used to write information on the storage grid, and contributes little to the total light output from the tube.

The cathode of the writing gun is generally operated at a high negative potential (typically -2000 volts) with respect to the viewing-gun cathode.

The writing-beam electrons land on the storage grid with such a velocity that its secondary-electron emission ratio is greater than unity. Thus, more electrons leave the storage grid than arrive, and elements of the storage grid assume a more positive charge wherever the writing beam strikes. Because the secondary electrons are attracted to the collector, the writing beam tends to charge the storage grid to the potential of the collector. However, the maximum potential to which an element of the storage grid rises is limited in normal operation by viewing-beam landing to a potential just slightly more positive than that of the viewing-gun cathode.

By controlling the intensity of the writing-beam current, it is possible to control the amount of positive charge deposited on any storage element. Consequently, a storage element can be established in a stable condition at any potential intermediate between the storage-grid cutoff voltage and approximately zero voltage. These potentials, in turn, control the transmission of the viewing-beam current to the screen, as shown in Fig.3, and produce a half-tone display.

Because the useful range of storage-grid potentials is entirely negative with respect to the viewing-gun cathode, the process of viewing does not in itself cause any deterioration of the stored information. Viewing duration is ultimately limited by the landing of positive ions produced in the region of the target on the storage grid, or by a controlled erasure rate when *dynamic erasure* is employed.

The great multiplicity of elements of the storage grid makes possible the storage and display of half-tone patterns of high resolution. At a display brightness of 50 per cent of saturated brightness, a typical resolution of 50 lines per inch is measured by the "shrinking raster" method. Display-storage tubes designed for high resolution show as much as 110 lines per inch.

The Erasing Operation

Static Erasure. The negative charging of the storage grid when bombarded by the low-velocity viewing beam provides a mechanism by which an undesired charge pattern on the storage grid can be erased. A multiplicity of potentials is established on the storage grid by the modulated beam of the writing gun. Now, increasing the backplate voltage from +2 volts to +8 volts raises the potential of the individual elements of the storage grid to a potential between +6 volts—for an element which has been written to saturation—to zero volts for another element which was unwritten. The screen is now nearly uniformly illuminated at a level equal to, or slightly greater than, the saturated brightness. The low-velocity viewing beam lands on all areas which are at any positive potential, and brings them all to equilibrium at zero volts. Returning the backplate voltage to its original value of +2 volts drops the potential of the entire storage grid to a uniform -6 volts, which is the erased or cutoff condition. This technique is known as *static erasure.*

Using this technique, information written at any time remains at the written brightness level. The display at any moment comprises an integrated sum of all information written since the last erasure but does not permit the distinction of the time at which the information was written. During the erasing cycle the display conveys no information. After erasure, no information will be displayed until a new pattern is written.

The duration of a display may be extended to two minutes or more if half-tones are not involved in the display and if the signals to be written are above a minimum threshold value. The increased duration is achieved by use of an erasing voltage having an amplitude several volts higher than that required for complete erasure which produces an erased condition called "blacker than black". Such a voltage charges the unwritten storage elements more negative than the cutoff voltage and consequently increases the time necessary for ion landing to cause a visible build-up of background brightness. If true half-tone displays are required the amplitude of the erasing voltage should be adjusted to that value which brings the storage grid to just cutoff potential.

Dynamic Erasure. In many applications it is desired that writing be followed by a gradual decay of stored information. A gradual decay permits discrimination of the time at which the information was written. This performance is obtained by applying a continuous series of rectangular positive pulses to the backplate at a rate well above the flicker frequency of the human eye. Because the rate of the erasing pulses is above the flicker frequency of the eye, stored information will appear to an observer to be continuously displayed. A satisfactory pulse-repetition frequency is 200 cps. The technique of erasing by applying a series of pulses to the backplate is known as *dynamic erasure*.

The rate of decay of stored information depends on the width of the pulse and its repetition frequency. In contrast to the saturation brightness condition which occurs during static erasure, dynamic erasure gives the appearance of a low level of background brightness resulting from the erasing pulses. The rate of decay of stored information and the apparent background brightness caused by the pulses is proportional to the product of their width and repetition rate.

Brightness-decay characteristics for a typical display-storage tube dynamically erased are shown in Fig.4. Under the assumed erasing conditions shown in Fig.4, the display can be erased by a single 6-volt rectangular pulse of approximately 24 milliseconds duration, or by a series of 6-volt pulses having a total duration of 24 milliseconds. Erasing pulses whose amplitudes are smaller than the magnitude of the viewing-beam cutoff voltage do not permit complete erasure. On the other hand, erasing pulses whose amplitude is greater than the magnitude of the viewing-beam cutoff voltage eventually drive the storage grid beyond cutoff, i.e., to a value "blacker than black". While this may appear to give faster erasure, it will result in the loss of small signals. Therefore, the erasing-pulse amplitude should not be used to adjust the erasing speed.

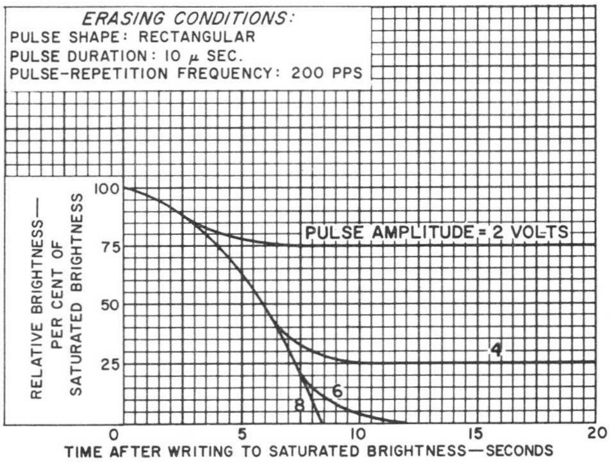

Fig.4 - Typical Erasing Characteristics of a Display-Storage Tube.

In some applications the saturated brightness condition of static erasure or the low level of background brightness during dynamic erasure may be objectionable. These conditions can be eliminated by reducing the applied screen voltage during that portion of the erasure cycle when the backplate is raised to a value more positive than its normal operating voltage.

OPERATING CONSIDERATIONS

The precautions which must be observed to obtain reliable service from display-storage tubes are considerably more numerous than those to be observed for the more familiar oscillograph-type cathode-ray tube. If these precautions are observed, these devices may be operated with a high degree of confidence in obtaining reliable and trouble-free service throughout the warranty period and beyond.

This section contains information which, when used along with the maximum ratings established for the individual tube type will prevent the occurence of electrical situations which may result in permanent storage-tube damage. *Only items likely to result in permanently damaged tubes are listed below. Items affecting only the quality of tube performance have been purposely omitted.* It is highly recommended that safeguards to protect against the situations described below be designed into the equipment to prevent inadvertent display-storage tube damage.

Maximum Ratings. Failure to stay within the absolute-maximum ratings of the tube as shown in the technical bulletins will result in impaired tube life or immediate tube destruction. For this reason, it is advisable to design voltage controls in such a manner that it is impossible to apply to the tube a voltage exceeding its maximum rating. Often, excessive voltages result from open and short circuits in power-supply circuits, or from an open electrode-terminal connection. In the latter case, the corresponding tube electrode can float to uncontrolled potentials.

Screen-Circuit Impedance. An adequately rated one-megohm (minimum) resistor must be in series with the screen-terminal lead. Capacitance to ground (or elsewhere) from the section of the lead between the resistor and the screen terminal must be very low. For this reason, this section of the lead must be unshielded, must be no more than about one foot long, and must have no capacitors connected to it. The resistor should be rated at 2 watts and an end-to-end voltage of 7500 volts.

Failure to include this resistor almost invariably results in tube damage. Damage usually consists of an open internal screen connection caused by excessive screen current. When attempts are made to operate such tubes, no light is observed coming from the phosphor screen. Mechanical damage to the phosphor screen can often be observed in non-operating tubes.

Collector-Circuit Impedance. A 10,000 ohm (minimum) resistor must be in series with the lead to the collector terminal. Capacitance to ground (or elsewhere) from the section of the lead between the resistor and the collector terminal must be very low. For this reason, this section of the line must be unshielded, must be no more than about 3 feet long, and must have no capacitors connected to it. The resistor, to be protected in the event of a collector short circuit, should be rated for service at 10 watts and 500 volts.

Failure to include this resistor occasionally results in permanent damage to the storage surface due to excessive collector current. This damage is local in extent and appears in the display as small permanent bright spots. However, not all bright spots are caused by omission of this resistor.

Excessive Writing-Beam Current Density. The writing-beam current density of any area of the storage grid should be no more than is necessary to write that area to saturated brightness during one scan of the writing beam. Excessive writing-beam current density can permanently damage the storage surface.

Such damage ordinarily is local in extent and appears as permanent light or dark areas or spots in the display, coincident with areas struck by the excessive writing beam. In severe cases, mechanical damage to the phosphor screen can be observed on the face of the non-operating tube.

Under ordinary operating conditions, sufficient latitude exists in the maximum ratings so that a small degree of excessive writing-beam current density does not cause damage, unless prolonged for several hours. Nevertheless, it is strongly recommended that writing-beam current never be greater than that required for a given application.

During the operation of display-storage tubes, certain situations may arise that can quickly cause excessive writing-beam current density and consequent damage. These situations and safeguards against them are described below.

Failure of Scanning. Failure of scanning while the writing beam is turned on results in excessive writing-beam current density which often results in localized permanent storage-grid damage. Provision should be made to cut off the writing-beam current automatically in case of a scanning failure. The writing-beam current can be cut off by an electronic switch which applies -200 volts bias to grid No. 1 of the writing gun. This switch should be actuated by a portion of the scanning voltages applied to both sets of deflecting electrodes.

Loss of Bias. Loss of writing-gun control-grid bias, or loss of blanking, which causes the writing-gun control grid to be at or near zero bias, will result in excessive writing-beam current which may result in localized permanent damage to the storage grid.

Turning on Equipment. In some cases, the order in which voltages are applied to display-storage tubes when equipments are turned on can give rise to a situation of "no bias" or "no scanning". If writing-gun high voltage is applied before writing-gun bias, a zero-bias condition will exist. If writing-gun high voltage is applied before the writing-gun deflection voltages, a "no scanning" condition will exist. In these cases, damage as described above can occur. It is obvious that an extremely serious condition exists when the writing-gun high voltage is applied before either bias or deflection voltages.

In some equipments, the application of bias to the writing-gun control grid is delayed because of high impedance in the control-grid-to-bias-supply return circuit. One way to avoid this condition is to use a time-delay relay, operating from the writing-gun high-voltage switch, to connect the writing-gun control grid to a low-impedance point of the bias supply at a bias voltage sufficiently great to cut off the writing-gun beam until after the high voltage is applied.

To avoid a condition of runaway charging and possible tube damage, it is necessary that the viewing beam be operating before the writing beam is turned on. Allow the viewing-gun heater to reach operating temperature, and allow the viewing-gun beam current to reach normal operating value before turning on the writing-gun beam current. Furthermore, always keep the viewing-gun beam on till the writing beam is turned off.

Runaway Charging. A condition of runaway charging of the storage grid may result if the writing beam is allowed to land on the storage grid with the viewing beam turned off, if the writing beam is incident on an area of the storage grid not covered by the viewing beam, or even though the viewing beam is turned on if the current density in the writing beam exceeds that in the viewing beam. Such a runaway condition can occur because of the non-equilibrium writing process involved.

Because the electrons in the writing beam land with an energy such that the secondary-emission ratio of the storage-grid surface is greater than unity, this surface charges positively toward collector potential. Normally, the landing on the storage grid of the viewing-beam electrons keeps any portion of the storage-grid surface from charging above viewing-gun cathode potential. When this limiting action of the viewing beam is not present, the storage-grid surface may charge under the action of the writing beam to a value such that sparking occurs through the insulating layer between the storage-grid surface and the backplate. This sparking is observed as random bright flashes on the screen. In the event of sparking, permanent damage (loss of the ability to store a signal in localized areas) to the storage grid may result. Such damage can sometimes be avoided if the writing process is quickly stopped.

Reduced Viewing-Beam Diameter. In many display-storage tubes, the application of certain ranges of voltage to the viewing-gun grids will cause the viewing beam to be focused into a small spot. In this condition, the viewing beam is quite intense and can change the secondary-emission properties of the storage grid in the bombarded area. The voltage ranges assigned to the various viewing-gun grids in the technical bulletins under Maximum Ratings are chosen so that the viewing-beam current cannot be focused into a small spot.

In summary, the following precautions must be followed to protect the display-storage tube from inadvertent damage—

1. Do not exceed maximum ratings.
2. Be sure to include the screen resistor.
3. Be sure to include the collector resistor.
4. Do not apply excessive writing-beam current density.
5. Protect against scanning failure.
6. Protect against loss of bias.
7. Apply voltages to tube in correct order.
8. Never write unless viewing beam is on.
9. Stay within recommended viewing-grid voltage ranges.

GENERAL CONSIDERATIONS

Handling. The display-storage tube should preferably be transported or handled with the face up. Care should be taken to prevent knocking or bumping the bulb terminals. Such rough treatment may cause either immediate or delayed cracking of the metal-glass seals.

Support. Display-storage tubes which are not provided with an integral magnetic shield may be mounted by using a padded clamp around the neck of the tube and by sponge-rubber supports around the tube, except near the bulb caps. The tube should not be supported by the base or socket. Support for display-storage tubes having an integral magnetic shield is generally effected by using padded clamps around the neck and large diameter of the tube unless otherwise specified in the technical bulletins.

Supporting systems for "ruggedized" display-storage tubes should take into consideration mounting arrangements that will take full advantage of the environmental ratings of the tube.

Shielding. Magnetic shielding, if not integral in the display-storage tube, should always be provided to prevent external fields from interfering with the required accurate control of the low-velocity viewing beam. A cylindrical shield of properly annealed high-permeability material about 1/16-inch thick is usually satisfactory. The integral shielding provided in some display-storage tubes is satisfactory for most applications.

Degaussing. Display-storage tubes supplied both with or without integral magnetic shields should be degaussed before being placed in operation. A degaussing coil suitable for use with 5-inch display-storage tubes may be made by winding 900 turns of No. 17 enameled wire on a 7-inch diameter form 2 inches long. After connecting the coil to a suitable supply line (220 vac, 60 cps), slowly (taking at least 30 seconds) pass the display-storage tube through the coil and then slowly withdraw it completely from the ac magnetic field. Repeat this procedure at least two times. The tube should be removed at least five feet distant from the coil before disconnecting the coil from the supply line.

Deflection Considerations for Electrostatic Types. As with conventional oscillograph tubes, balanced electrostatic-deflection circuits should be employed. Each pair of the deflecting electrodes should be operated at an average potential about the same as that of grid No. 4 of the writing gun.

Video-Drive Considerations. In most applications the information to be stored and displayed by the tube should be applied as a video signal to the control grid (grid No. 1) or cathode of the writing gun. The writing-gun control grid should never be more positive than necessary to write the display to saturated brightness for a given scanning speed and drive condition. In determining the writing-drive requirements, it should be remembered that writing is essentially a charge-depositing process. The instantaneous writing-beam current needed for saturated writing varies directly with the speed at which the writing beam is deflected across the storage grid and varies inversely with the number of times a given storage element is written upon in one complete scan period.

The high voltages at which display-storage tubes operate may be very dangerous. Great care should be taken in the design of apparatus to prevent the operator from coming in contact with the high voltages. Safety precautions include the enclosing of high-potential terminals and the use of interlocking switches to break the primary circuit of the power supply when access to the equipment is desired.

In the use of high-voltage tubes, it should always be remembered that high voltages may appear at normally low-potential points in the circuit as a result of capacitor breakdown or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned off, and both terminals of any capacitors grounded.

The Use of Safety Glasses. It is recommended that shatter-proof protective glasses be worn when handling display-storage tubes having a diameter greater than 5 inches to help protect operators against tube implosion should the tube be accidentally struck.

REFERENCES

MIT Radar School Staff, PRINCIPLES OF RADAR, McGraw-Hill Book Co., Inc.

M. Knoll and B. Kazan, STORAGE TUBES AND THEIR BASIC PRINCIPLES, John Wiley and Sons, Inc.

M. Knoll, P. Rudnick, and H.O. Hook, *Viewing Storage Tube with Halftone Display*, RCA REVIEW, Vol.14, No.4, December 1953.

M. Knoll, H.O. Hook, and R.P. Stone, *Characteristics of a Transmission Control Viewing Storage Tube with Halftone Display*, PROC. I.R.E., Vol.42, No.10, October 1954.

M. Knoll and B. Kazan, *Viewing Storage Tubes*, ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS, Vol.VIII, 1956, Academic Press, N.Y., pp.448-501.

R.P. Stone, *Use of the Potential Shift Diagram for Analysis of the Operation of Display-Storage Tubes*, PROC. NATIONAL ELECTRONICS CONFERENCE, Vol.XIII, 1957.

RCA

This bulletin is to be used in conjunction with the publication 1CE-277 "RCA Display-Storage Tubes".

RCA-7268B DISPLAY-STORAGE TUBE

Factory-Collimated "Ruggedized" Type Having High Display Uniformity, 4"-Diameter Display, Two Writing Guns, One Viewing Gun, Integral Magnetic Shield

The 7268B is unilaterally interchangeable with types 7268 and 7268A

RCA-7268B is a "ruggedized" 5"-diameter direct-view electrostatic-focus and -deflection type of display-storage tube designed for use in military and commercial information handling displays where rough tube usage may be encountered. It has two writing guns which permit the simultaneous writing of two independent signals and a single viewing gun.

The viewing-beam of the 7268B is factory collimated for optimum tube performance, minimum circuit requirements, simplified setup procedure, and to eliminate the possibility of tube damage because of improper viewing-beam adjustment. Optimum collimation is obtained by use of passive circuit elements incorporated within the magnetic shield-tube assembly. Only two fixed voltages are required to obtain optimum collimation which remains constant throughout tube life even though the supply voltages may vary.

The 7268B is capable of providing a non-flickering 4"-diameter display having uniform brightness and excellent positional accuracy of written signals under environmental conditions involving severe vibration, extremes in temperature and pressure, salt spray, and high humidity.

Its rugged internal structure, high brightness, and an adjustable rate of information decay make the 7268B especially useful, under daylight viewing conditions, in airborne fire-control radar systems.

FEATURES

- **Factory Collimation of Viewing Beam for Optimum Tube Performance**
- **Constant Collimation throughout Tube Life**
- **Minimized Circuitry Requirements**
- **Simplified Setup Procedure**
- **High Display Uniformity**
- **Excellent Resolution —70 lines per inch (min.)**
- **High Display Brightness —2500 footlamberts (typical)**
- **High Display Accuracy**
- **Two Writing Guns Having Close Registration Capability**
- **Designed to Withstand the Severe Environmental Requirements of Airborne Equipment**
- **Integral Magnetic Shield**
- **Ability to Integrate Signals in the Presence of Noise**

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Electronic Components and Devices Harrison, N. J.

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7268B 12-65
Printed in U.S.A.

DATA

Electrical:

Heater, for Unipotential Cathode (All guns):	
Voltage (AC or DC)	6.3 ± 10% volts
Current at 6.3 volts	0.6 A
Cathode Heating Time (Minimum) before other electrode voltages are applied	30 sec

Writing Section — Each Gun:

Focusing Method	Electrostatic
Deflection Method	Electrostatic
Deflecting-Electrode Arrangement	See *Dimensional Outline*
Direct Interelectrode Capacitances:	
Grid No.1 to all other electrodes	15 max. pF
Cathode to all other electrodes	8 max. pF
Deflecting electrode DJ1 to deflecting electrode DJ2	3 max. pF
Deflecting electrode DJ3 to deflecting electrode DJ4	2 max. pF
DJ1 to all other electrodes	10 max. pF
DJ2 to all other electrodes	10 max. pF
DJ3 to all other electrodes	10 max. pF
DJ4 to all other electrodes	10 max. pF

Viewing Section:

Direct Interelectrode Capacitance:	
Backplate to all other electrodes	110 max. pF

Optical:

Phosphor	P20, Aluminized

Mechanical:

Minimum Useful Viewing Diameter	4"
Maximum Overall Length	16"
Maximum Diameter (Excluding screen lead)	5.28"
Screen-Connector Assembly	See *Dimensional Outline*
Base	JEDEC No.B25-216
Bulb Terminals:	
Caps (Three)	Recessed Small Ball (JEDEC No.J1-22)
Operating Position	Any
Weight	5-1/4 lbs

Maximum and Minimum Ratings, *Absolute-Maximum Values:*[a]

All voltages are shown with respect to the reference terminal of the collimation system unless otherwise specified. The reference terminal must be grounded.

	Min.	*Max.*	
Screen Voltage:			
Peak	–	11500	volts
DC	0	11000	volts
DC Backplate Voltage	0	35	volts
Collimation-System[b] Positive-Terminal Voltage	0	300	volts
Collimation-System[b] Negative-Terminal Voltage	–100	–50	volts
Viewing-Gun Heater	–125	125	volts
Magnetic Shield Voltage	–200	200	volts
Deflecting-Electrode Voltage (Each Gun)	–600	600	volts
Writing-Grid-No.3 Voltage (Each Gun)[c]	0	2000	volts
Writing-Grid-No.1 Voltage (Each Gun)[c]	–200	(d)	volts
Writing-Gun Cathode Voltage (Each Gun)	–2800	0	volts
Writing-Gun Heater-To-Cathode Voltage (Each Gun)	–125	125	volts
Series Current-Limiting Resistor (Unbypassed) in Screen Circuit	1	–	megohm
Series Current-Limiting Resistor (Unbypassed) in Collimation System Positive Terminal Circuit	0.005	–	megohm

Recommended Operating Values:

All voltages are shown with respect to the reference terminal of the collimation system unless otherwise specified.

Screen Voltage	10000	volts
Backplate Voltage[e]	2	volts
Collimation-System[b] Positive-Terminal Voltage	265	volts
Collimation-System[b] Negative-Terminal Voltage	–55	volts
Collimation-System[b] Reference Terminal		grounded
Writing-Grid-No.3 Voltage (Each Gun)[f]	–2325 to –1975	volts
Writing-Grid-No.1 Voltage (Each Gun)	(dg)	volts
Writing-Gun Cathode Voltage	–2400	volts
Magnetic Shield Voltage	0	volts
Average Deflecting Plate Voltage[h]	100	volts
Circuit Values:		
Grid-No.1 Circuit Resistance (Either Gun)	1 max.	megohm
Impedance in Any Deflecting Electrode Circuit[i]	0.01 max.	megohm
Backplate-Circuit Resistance	0.005 max.	megohm
Series Current-Limiting Resistor (Unbypassed) in Screen Circuit	1	megohm
Series Current-Limiting Resistor (Unbypassed) in Collimation System Positive Terminal Circuit	0.005	megohm

Characteristics:

	Min.	Typ.	Max.	
Useful Viewing Diameter	4	–	–	inches
Brightness (Luminance)[k]	–	2500	–	footlamberts
Viewing Duration [m]	15	–	–	seconds
Erase Time[n]	–	28	–	milliseconds
Resolution[p]	70	–	–	lines/in.
Undeflected Spot Position	–	–	(q)	millimeters
Deflection Factors:				
DJ1 & DJ2	82	–	100	volts/inch
DJ3 & DJ4	82	–	100	volts/inch

Performance Data

Writing Ability and *Writing Uniformity* Characteristics are measured singly for both guns. A 3.5" x 3.5" raster is centered on the tube face. Vertical scanning is accomplished by an interrupted linear sawtooth waveform having a scan time of 625 microseconds and a prf of 500 pps. Horizontal scanning is provided by a triangular waveform having a scan rate of 3.5 inches per second.

Writing Ability. The writing-gun grid No.1 of the gun under test is driven above cutoff during the vertical scan time by white noise, of approximately 5 megacycle bandwidth, having a zero-to-peak amplitude of approximately 35 volts. The display brightness under these conditions shall be at least 20% of saturated brightness.

Writing Uniformity. This characteristic is determined under the same conditions as specified above except that the rms amplitude of the white noise is adjusted to produce brightness of 40% of saturated brightness at the dimmest area in the display. The measured brightness at the brightest area of the display shall be not more than 60% of saturated brightness.

Environmental Tests:

The 7268B is designed to withstand the following operational and non-operational environmental tests.

Operational Tests.

Sinusoidal Vibration: This test consists of tube vibration in each of three orthogonal axes. One of these axes is in the plane passing through the major axis of the tube and the center of the tube-base key. The tube is mounted so that its major axis is parallel to the plane of the earth. A total of 6 cycles of swept sinusoidal vibration, from 10 to 500 and back to 10 cycles per second, is performed. The duration of a sweep cycle is 15 minutes. The frequencies of any resonant points are noted. The sinusoidal vibration schedule is shown below.

Double Amplitude inches	Peak Acceleration g's	Sweep Frequency c/s	Sweep Cycle Duration minutes
0.27	–	10 to 20	15
–	4	20 to 46	
–	2	46 to 500	
–	2	500 to 46	
–	4	46 to 20	
0.27	–	20 to 10	

Vibration at Resonance. This test consists of tube vibration at the resonant point or points determined in *Sinusoidal Vibration* for a period of 30 minutes. If more than one resonant point is noted for a given axis, the tube is vibrated for a total of 30 minutes at that resonant point in each axis most likely to produce tube failure. If no resonant points are determined in *Sinusoidal Vibration,* the tube is vibrated for 60 minutes at a frequency of 55 cycles per second.

Low Pressure-High Temperature. This test consists of tube storage for a period of not less than one hour at a temperature of +100° C. At the termination of this storage period, the tube is operated with the values shown under *Recommended Operating Values* applied and at a pressure equivalent to an altitude of 32,000 feet. The temperature is then reduced to +53° C. The tube is stored at this temperature for 1 hour and then is operated with normal voltages applied at a pressure equivalent to an altitude of 60,000 feet.

Low Temperature. This test consists of the tube being maintained at a temperature of –65° C for 48 hours. At the end of this period and while the tube is still at –65° C, the tube is operated with recommended voltages applied for 15 minutes.

Non-Operational Tests:

Temperature Cycling. This test consists of tube storage for a period of not less than 2 hours at a temperature of -65^{o} C followed within 5 minutes by storage for a period of 2 hours at a temperature of $+100^{o}$ C. A minimum of five consecutive cycles are performed.

High Pressure. This test consists of tube exposure to an absolute pressure of 45 pounds per square inch for a period of at least 60 seconds. This pressure shall be attained within 60 seconds.

Torque. This test consists of the application of a torque of 40 inch-pounds between the integral magnetic shield and the tube base.

Salt Spray. This test consists of tube exposure to a fine spray from a salt solution for a period of 48 hours. The ambient temperature is maintained at approximately 35^{o} C.

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[a]The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[b]The collimation system includes a passive internal network which provides the proper voltages for all viewing gun electrodes; except screen, backplate and heater; as well as grids No.2 and 4 of the writing gun.

[c]Voltages are shown with respect to cathode of writing gun.

[d]The writing-gun grid No.1 should never be more positive then necessary to write the display to saturated brightness for a given scanning and drive condition. In no case should the writing-gun grid-No.1 voltage have a value greater than zero with respect to the writing-gun cathode.

[e]The backplate should be maintained at 2 volts between erasing pulses when dynamic erasure is employed.

[f]Adjusted for the smallest, most circular spot.

[g]The bias-voltage value for writing-beam cutoff is between −60 and −100 volts with respect to writing-gun cathode.

[h]With respect to the reference terminal of the collimation system for each pair of deflecting electrodes.

[i]Recommended value for minimum distortion because of viewing-beam collection by the deflecting plates. Where strict display accuracy and display uniformity are not required, the impedance value for any deflecting-electrode circuit may be as high as 0.1 megohm maximum. For optimum performance, it is recommended that the deflecting-electrode-circuit impedances be approximately equal.

[k]Brightness (Luminance) is measured after the entire display is written to saturated brightness, the writing gun has been turned off, and with no erasing pulse applied.

[m]The time required for any 0.5-inch diameter area of the 4"-diameter viewing area to rise spontaneously (with no writing or erasing) from zero brightness (viewing-beam visual cutoff) to 10% of saturated brightness.

[n]With the display at saturated brightness, a series of rectangular pulses 5 milliseconds in width and at a repetition frequency of 2 pps is applied to the backplate. The number of pulses required to just erase completely the center of the display is noted. This number is multiplied by 5 milliseconds to obtain the erase time. The amplitude of the erase pulses is adjusted to obtain the minimum erase time.

[p]Measured by the "shrinking" raster method under conditions of continuous writing and erasing, with erase pulses of 60 μsec width and a repetition frequency of 300 pps. The amplitude of the erase pulses is adjusted to provide 3.5-second erasure and grid No.1 is adjusted to provide 1000 footlamberts brightness of the just "shrunken" raster.

[q]The undeflected spot position must fall within a square having a 15 millimeter side (maximum) centered on the tube face and parallel to a trace produced by one set of deflectting plates.

OPERATING PROCEDURE

The following steps should be followed when the 7268B is first placed in operation. Refer to the precautions shown under *Operating Considerations* in the publication 1CE-277 "RCA Display-Storage Tubes". *Note that all electrode voltages are referred to the reference terminal of the collimation system unless otherwise specified.*

1. *Viewing Gun* – Ground the collimation system reference terminal and magnetic shield. Apply power to the heater of the viewing gun and allow 60 seconds for the cathode to reach normal operating temperature. Next apply the following voltages, in the indicated order: +2 volts to the backplate, –55 volts to the collimation system negative terminal, and +265 volts to the collimation system positive terminal (be sure a minimum resistance of 5000 ohms is in this circuit). Then increase screen voltage slowly from 0 volts to 10,000 volts (be sure a minimum resistance of 1 megohm is in the screen circuit). Next apply dynamic erasing pulses to the backplate.

   The storage property of the tube can be observed by setting the amplitude of the dynamic erasing pulses at +8 volts for several seconds and by then reducing it to zero volts. As the erasing pulse amplitude is reduced the screen should go dark. The 7268B is now storing an overall "black picture" and stays in this condition until the screen begins to brighten as a result of the storage grid being gradually discharged by positive ions landing on it.

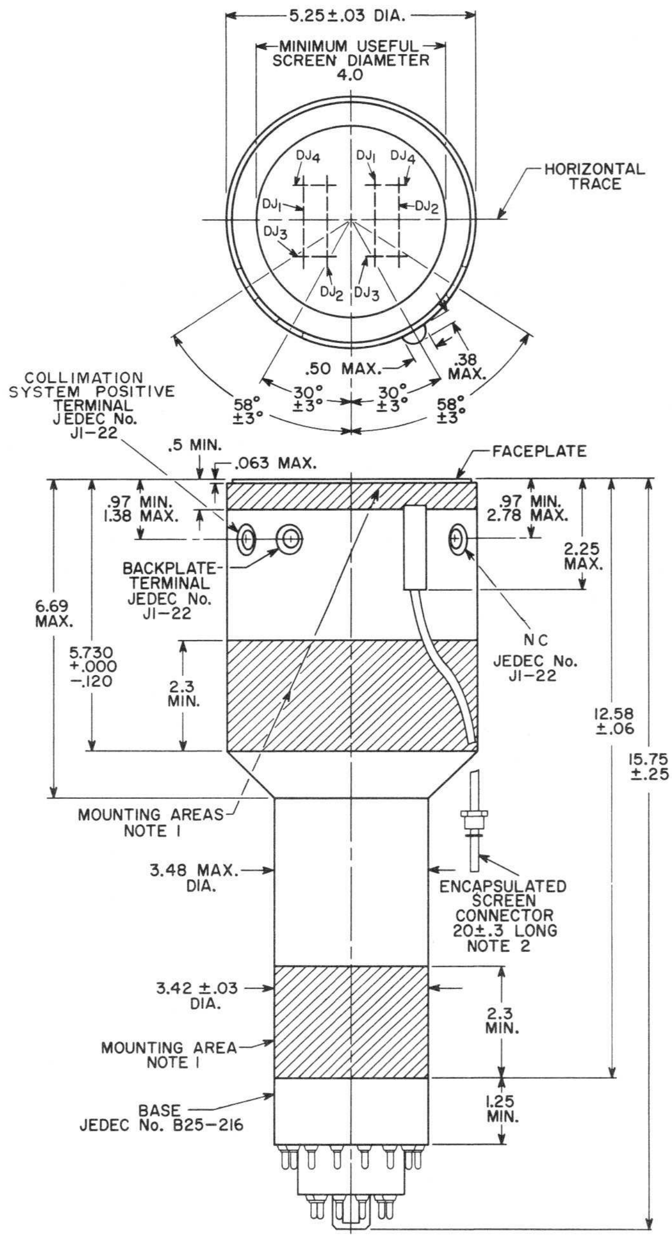
2. *Writing Gun* – Apply power to the heater of the writing gun and allow 60 seconds for the cathode to reach normal operating temperature. Then, with reference to the typical operating values shown in the tabulated data under *Recommended Operating Values*, set the grid-No.1 voltage to cutoff, and apply dc voltages to the electrodes of the writing gun. With the screen made dark by the charging method described under (1), the grid-No.1 bias is reduced until the writing beam is seen as a spot on the screen. If the beam is caused to move, either by centering adjustment or by application of deflection voltage, it should leave a bright trace. After an area has been written to full brightness, the writing-beam spot may be seen as a slightly brighter spot on the bright background. Writing-beam focus can then be optimized by adjusting the grid-No.3 voltage.

3. *Final Display Adjustments* – The dc bias and the video-signal amplitude applied to grid No.1 or cathode of the writing gun should be adjusted to set the black level and the highlight level in the display. These adjustments depend on the scanning rate used. Resolution decreases with increasing writing-gun beam current. Excessive writing-gun beam current will produce screen saturation and any further beam-current increase will not produce additional highlight brightness and may also decrease half-tone rendition. It is recommended that the writing-beam current always be adjusted to a minimum value to produce the best display without saturation of highlight brightness. The dynamic erasing-pulse amplitude and duty cycle should be adjusted in accordance with the information contained in 1CE-277.

The following operating precautions must be followed to protect the 7268B from inadvertent damage –

1. Do not exceed maximum ratings.
2. Be sure to include the screen resistor.
3. Be sure to include the collimation system positive terminal resistor.
4. Do not apply excessive writing-beam current density.
5. Protect against scanning failure.
6. Protect against loss of bias.
7. Apply voltages to tube in correct order.
8. Never write unless viewing beam is on.

DIMENSIONAL OUTLINE

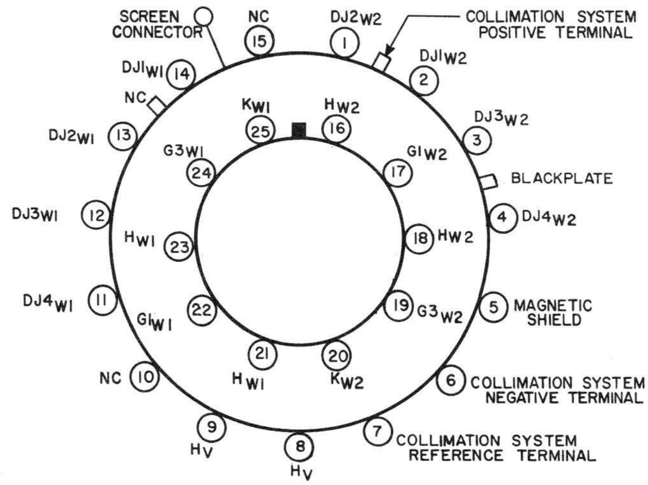


DIMENSIONS IN INCHES

NOTE 1: The indicated areas are recommended for mounting purposes.

NOTE 2: Amp Part No. AMP 832 692–0; manufactured by Aircraft Marine Products, Inc., Harrisburg, Pa., or equivalent.

BASING DIAGRAM
Bottom View



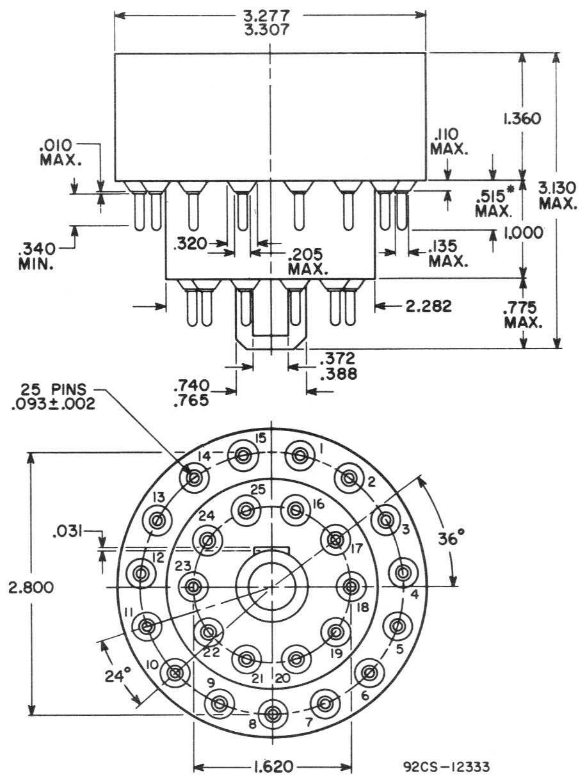
Pin 1: Deflecting Electrode DJ2 of Writing Gun No.2
Pin 2: Deflecting Electrode DJ1 of Writing Gun No.2
Pin 3: Deflecting Electrode DJ3 of Writing Gun No.2
Pin 4: Deflecting Electrode DJ4 of Writing Gun No.2
Pin 5: Integral Magnetic Shield
Pin 6: Collimation System Negative Terminal
Pin 7: Collimation System Reference Terminal
Pin 8: Heater of Viewing Gun
Pin 9: Heater of Viewing Gun
Pin 10: NC – No Internal Connection
Pin 11: Deflecting Electrode DJ4 of Writing Gun No.1
Pin 12: Deflecting Electrode DJ3 of Writing Gun No.1
Pin 13: Deflecting Electrode DJ2 of Writing Gun No.1
Pin 14: Deflecting Electrode DJ1 of Writing Gun No.1
Pin 15: NC – No Internal Connection
Pin 16: Heater of Writing Gun No.2
Pin 17: Grid No.1 of Writing Gun No.2
Pin 18: Heater of Writing Gun No.2
Pin 19: Grid No.3 of Writing Gun No.2
Pin 20: Cathode of Writing Gun No.2
Pin 21: Heater of Writing Gun No.1
Pin 22: Grid No.1 of Writing Gun No.1
Pin 23: Heater of Writing Gun No.1
Pin 24: Grid No.3 of Writing Gun No.1
Pin 25: Cathode of Writing Gun No.1
Flexible Lead: Screen (Encapsulated)
Recessed Small Ball Caps:

Over Pin No.3
NC – No Internal Connection

Over Pin No.13
Collimation System Positive Terminal

Over Pin No.14
Backplate

BASE DRAWING
25-PIN BASE
JEDEC No. B25-216



DIMENSIONS IN INCHES

*Add 0.030" for solder.

DISPLAY-STORAGE TUBES

Direct-View Types

Information shown on these pages is to be used in conjunction with RCA display-storage tube data.

RCA display-storage tubes of the direct-view type are used in applications that require a bright, non-flickering display of stored information containing half-tones for relatively long periods of time. They provide continuous displays having high contrast under conditions of high ambient light for many seconds after writing has ceased and integrate repetitive signals so that information can be distinguished from random noise. Typical applications using display-storage tubes include the following:

RADAR—*Ground, Airborne, and Marine*

- Fire control
- Search
- Weather
- Ground Mapping
- Proximity Warning
- Navigation

OTHER INFORMATION DISPLAYS

- Electronic Reconnaissance and Countermeasures
- Compressed Bandwidth Video Systems
- Oscillograph Displays of Non-recurrent Transients
- Sonar

The voltage and other values used in this publication do not apply to any particular display-storage tube type. Although these values may be typical, they are intended only to explain the principles of operation of the device. Refer to the data contained in the technical bulletin for a given tube type for specific ratings, operating values, and performance and characteristic values.

PRINCIPLES OF OPERATION

A schematic arrangement of a typical display-storage tube is shown in Fig. 1. The viewing electron gun produces a low-velocity, unfocused electron beam that continuously floods the target electrodes. The target electrodes consist of a phosphor screen (usually aluminized) on the inside surface of the faceplate, a backplate mesh covered with a thin layer of insulating material which serves as the storage grid, and a collector grid.

The writing gun (or guns) produces a well-defined high-velocity beam that is deflected, focused, and intensity modulated in the same manner as the beam of a cathode-ray tube.

The writing beam establishes a potential distribution on the storage grid which controls the viewing-beam current reaching the phosphor screen in the same manner as the grid voltage of a triode receiving tube controls its plate current, i.e., when the storage grid is established at negative voltages with respect to the viewing-gun cathode it can limit or cut off the viewing-beam current.

The tube may also contain a selective erasing gun which produces a low-velocity, focused beam that permits selective erasure of some areas of stored information on the storage grid without disturbing other areas.

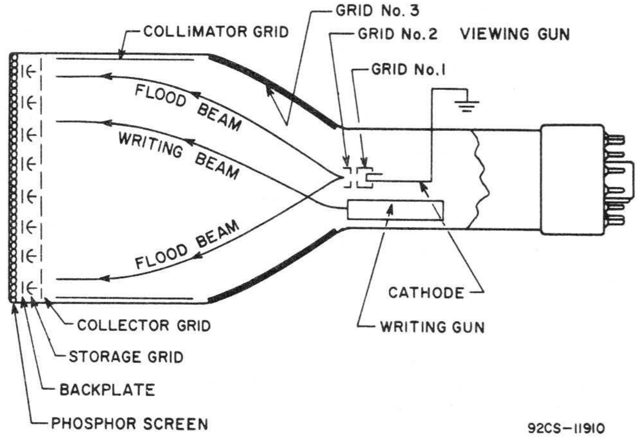


Fig. 1 - Schematic Arrangement of a Display-Storage Tube.

The operation of the display-storage tube may be described by separating it functionally into viewing, writing, and erasing operations.

The Viewing Operation

In addition to the viewing gun and the target elements, the viewing section contains additional electrodes for the collimation of the viewing beam.

The cathode, grid No. 1, and grid No. 2 of the viewing gun produce a high-density, low-velocity stream of electrons that is typically collimated (made parallel) and controlled in size by adjustment of grid-No. 1, grid-No. 3, and collimator-grid voltages. This collimated stream of electrons continuously floods the collector grid and the storage grid. Collimation is required so that the electrons, after passing through the collector grid, will approach all points on the storage grid in paths normal (perpendicular) to its surface. This normal approach of electrons having uniform velocity makes possible the uniform control of the electrons at every point on the storage grid.

Grid No.3 may be a conductive coating on the bulb-wall interior as shown in Fig.1. This figure also shows the location of the collimator grid which is often a metal cylinder that is mechanically supported by the target electrodes.

The collector grid is a fine metal mesh. It collects secondary electrons emitted from the storage grid during writing, and viewing-beam electrons turned back from the storage grid when the storage grid's potential is sufficiently negative. Also, because the collector grid is the most positive element thus far seen by the electron beams, it repels positive ions (produced by collision of electrons with residual gas molecules) and prevents ions in the region between the guns and the collector grid from landing on the storage grid and thus altering a stored charge pattern.

The storage grid consists of a very thin layer of material, having appropriate insulating and secondary-emission characteristics, that is deposited on the backplate, which is a fine metallic mesh. The deposit is on the gun side of the mesh, and leaves the size of the mesh openings essentially unchanged. In effect, the storage grid consists of a multiplicity of independent storage elements, each a capacitor. The thin layer of material of the storage grid serves as the dielectric, and its two surfaces serve as plates. One surface is in electrical contact with the backplate and the other surface faces the electron beams. The potential resulting from the charge stored in these individual capacitors determines the amount of viewing-beam current which reaches the corresponding areas of the phosphor screen, and therefore, controls the brightness of the display.

The backplate is ordinarily operated at a low positive potential (typically +2 volts) with respect to the viewing-gun cathode which is at ground potential. Assume the storage grid has the same potential as the backplate when the viewing section is initially placed in operation. The storage grid has this potential because the elemental capacitors are assumed to be discharged, i.e., there is no previously established charge pattern. Viewing-beam electrons passing through the collector grid are decelerated as they approach the storage grid, and because this grid is assumed initially to be +2 volts, it follows that they will land on its surface. Because of their low velocity, these electrons produce a secondary-emission ratio of less than unity and a net negative charge is deposited on the storage grid. As the negative charge builds up on the elemental capacitors, the potential of the storage grid drops. This process continues until the storage grid reaches an equilibrium value at viewing-gun cathode potential.

Under these conditions, a majority of the viewing-beam electrons passing through the collector grid are funneled through the storage-grid mesh openings to the phosphor screen and cause it to fluoresce over its entire area. In this condition, the brightness of the screen is designated as "saturated brightness".

Light output from the screen at saturated brightness varies with the voltage applied to the screen. As shown in Fig.2, the light output rises rapidly at screen voltages above a threshold of about 5000 volts for a display-storage tube having an aluminized screen. A display of high brightness is possible because each spot on the phosphor screen is continuously excited by the high-current viewing beam rather than intermittently excited as in conventional cathode-ray tubes. A high-current flooding-type viewing beam can be used because the display function (viewing) is separated from the information input function (writing) and consequently, external focusing, deflection, and modulation of the viewing beam are not required.

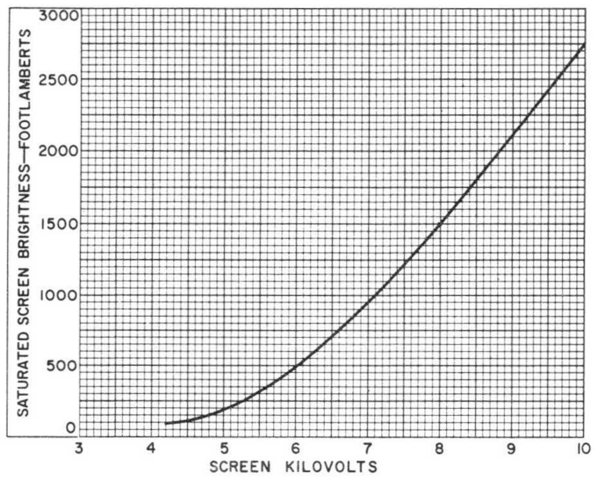


Fig.2 - Typical Brightness Characteristic of a Display-Storage Tube Having an Aluminized Screen.

Assume that the entire storage grid has been uniformly charged to viewing-gun cathode (ground) potential and that the backplate is at +2 volts. The display is now at saturated brightness. The viewing beam may be cut off from the phosphor screen by making the storage grid sufficiently negative with respect to the viewing-gun cathode. This may be accomplished by shifting the backplate from its normal potential of +2 volts to a more positive potential, for example, +8 volts. Because of the capacitive coupling between the backplate and the storage grid, the storage grid rises an equal amount positive from its initial ground potential of zero volts to a potential of +6 volts. Viewing-beam electrons are now able to land on the storage grid and charge it in a negative direction. Charging continues until the storage-grid potential is reestablished at zero volts, while the backplate remains at +8 volts. Now, if the backplate potential is returned to its initial value of +2 volts, the storage-grid potential drops correspondingly to -6 volts, a voltage sufficient to assure cutoff. Electrons in the viewing beam are now turned back as they approach the storage grid and return to the collector. The phosphor screen is dark.

At values of storage-grid potential between those which produce viewing-beam cutoff and those which produce saturated brightness, the amount of viewing-beam current which penetrates the storage-grid openings, and hence the amount of light emitted by the screen, is a function of storage-grid potential. This effect is shown in Fig.3 for a typical display storage tube. For backplate voltages more positive than those assumed in Fig.3, this storage-grid characteristic tends to shift to the left. For phosphor-screen or collector-grid voltages less positive than those assumed in Fig.3, the characteristic tends to shift to the right and to exhibit more slope.

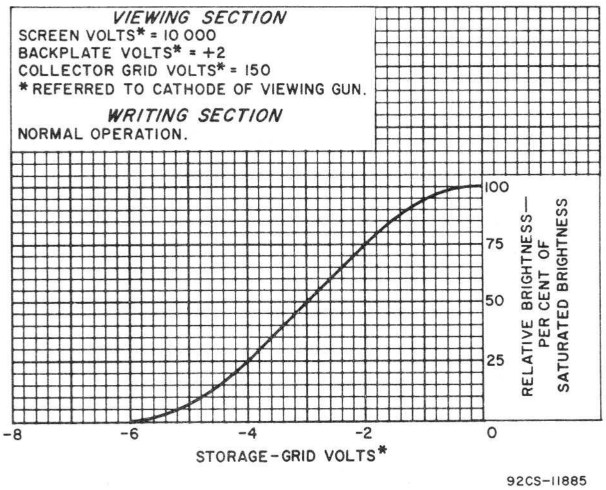


Fig.3 - Typical Storage-Grid Characteristic of a Display-Storage Tube.

The Writing Operation

The writing gun of the display-storage tube is similar to that of a cathode-ray tube. Its beam may be focused, deflected, and modulated in the same manner as the beam in a cathode-ray tube. It is used to write information on the storage grid, and contributes little to the total light output from the tube.

The cathode of the writing gun is generally operated at a high negative potential (typically -2000 volts) with respect to the viewing-gun cathode.

The writing-beam electrons land on the storage grid with such a velocity that its secondary-electron emission ratio is greater than unity. Thus, more electrons leave the storage grid than arrive, and elements of the storage grid assume a more positive charge wherever the writing beam strikes. Because the secondary electrons are attracted to the collector, the writing beam tends to charge the storage grid to the potential of the collector. However, the maximum potential to which an element of the storage grid rises is limited in normal operation by viewing-beam landing to a potential just slightly more positive than that of the viewing-gun cathode.

By controlling the intensity of the writing-beam current, it is possible to control the amount of positive charge deposited on any storage element. Consequently, a storage element can be established in a stable condition at any potential intermediate between the storage-grid cutoff voltage and approximately zero voltage. These potentials, in turn, control the transmission of the viewing-beam current to the screen, as shown in Fig.3, and produce a half-tone display.

Because the useful range of storage-grid potentials is entirely negative with respect to the viewing-gun cathode, the process of viewing does not in itself cause any deterioration of the stored information. Viewing duration is ultimately limited by the landing of positive ions produced in the region of the target on the storage grid, or by a controlled erasure rate when *dynamic erasure* is employed.

The great multiplicity of elements of the storage grid makes possible the storage and display of half-tone patterns of high resolution. At a display brightness of 50 per cent of saturated brightness, a typical resolution of 50 lines per inch is measured by the "shrinking raster" method. Display-storage tubes designed for high resolution show as much as 110 lines per inch.

The Erasing Operation

Static Erasure. The negative charging of the storage grid when bombarded by the low-velocity viewing beam provides a mechanism by which an undesired charge pattern on the storage grid can be erased. A multiplicity of potentials is established on the storage grid by the modulated beam of the writing gun. Now, increasing the backplate voltage from +2 volts to +8 volts raises the potential of the individual elements of the storage grid to a potential between +6 volts—for an element which has been written to saturation—to zero volts for another element which was unwritten. The screen is now nearly uniformly illuminated at a level equal to, or slightly greater than, the saturated brightness. The low-velocity viewing beam lands on all areas which are at any positive potential, and brings them all to equilibrium at zero volts. Returning the backplate voltage to its original value of +2 volts drops the potential of the entire storage grid to a uniform -6 volts, which is the erased or cutoff condition. This technique is known as *static erasure*.

Using this technique, information written at any time remains at the written brightness level. The display at any moment comprises an integrated sum of all information written since the last erasure but does not permit the distinction of the time at which the information was written. During the erasing cycle the display conveys no information. After erasure, no information will be displayed until a new pattern is written.

The duration of a display may be extended to two minutes or more if half-tones are not involved in the display and if the signals to be written are above a minimum threshold value. The increased duration is achieved by use of an erasing voltage having an amplitude several volts higher than that required for complete erasure which produces an erased condition called "blacker than black". Such a voltage charges the unwritten storage elements more negative than the cutoff voltage and consequently increases the time necessary for ion landing to cause a visible build-up of background brightness. If true half-tone displays are required the amplitude of the erasing voltage should be adjusted to that value which brings the storage grid to just cutoff potential.

Dynamic Erasure. In many applications it is desired that writing be followed by a gradual decay of stored information. A gradual decay permits discrimination of the time at which the information was written. This performance is obtained by applying a continuous series of rectangular positive pulses to the backplate at a rate well above the flicker frequency of the human eye. Because the rate of the erasing pulses is above the flicker frequency of the eye, stored information will appear to an observer to be continuously displayed. A satisfactory pulse-repetition frequency is 200 cps. The technique of erasing by applying a series of pulses to the backplate is known as *dynamic erasure.*

The rate of decay of stored information depends on the width of the pulse and its repetition frequency. In contrast to the saturation brightness condition which occurs during static erasure, dynamic erasure gives the appearance of a low level of background brightness resulting from the erasing pulses. The rate of decay of stored information and the apparent background brightness caused by the pulses is proportional to the product of their width and repetition rate.

Brightness-decay characteristics for a typical display-storage tube dynamically erased are shown in Fig.4. Under the assumed erasing conditions shown in Fig.4, the display can be erased by a single 6-volt rectangular pulse of approximately 24 milliseconds duration, or by a series of 6-volt pulses having a total duration of 24 milliseconds. Erasing pulses whose amplitudes are smaller than the magnitude of the viewing-beam cutoff voltage do not permit complete erasure. On the other hand, erasing pulses whose amplitude is greater than the magnitude of the viewing-beam cutoff voltage eventually drive the storage grid beyond cutoff, i.e., to a value "blacker than black". While this may appear to give faster erasure, it will result in the loss of small signals. Therefore, the erasing-pulse amplitude should not be used to adjust the erasing speed.

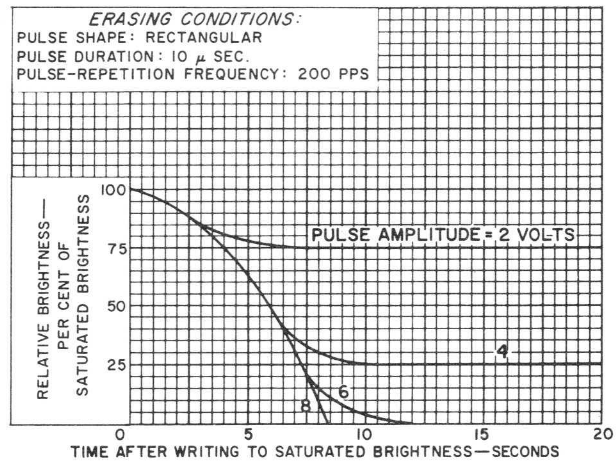


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Fig.4 - Typical Erasing Characteristics of a Display-Storage Tube.

In some applications the saturated brightness condition of static erasure or the low level of background brightness during dynamic erasure may be objectionable. These conditions can be eliminated by reducing the applied screen voltage during that portion of the erasure cycle when the backplate is raised to a value more positive than its normal operating voltage.

OPERATING CONSIDERATIONS

The precautions which must be observed to obtain reliable service from display-storage tubes are considerably more numerous than those to be observed for the more familiar oscillograph-type cathode-ray tube. If these precautions are observed, these devices may be operated with a high degree of confidence in obtaining reliable and trouble-free service throughout the warranty period and beyond.

This section contains information which, when used along with the maximum ratings established for the individual tube type will prevent the occurence of electrical situations which may result in permanent storage-tube damage. *Only items likely to result in permanently damaged tubes are listed below. Items affecting only the quality of tube performance have been purposely omitted.* It is highly recommended that safeguards to protect against the situations described below be designed into the equipment to prevent inadvertent display-storage tube damage.

Maximum Ratings. Failure to stay within the absolute-maximum ratings of the tube as shown in the technical bulletins will result in impaired tube life or immediate tube destruction. For this reason, it is advisable to design voltage controls in such a manner that it is impossible to apply to the tube a voltage exceeding its maximum rating. Often, excessive voltages result from open and short circuits in power-supply circuits, or from an open electrode-terminal connection. In the latter case, the corresponding tube electrode can float to uncontrolled potentials.

Screen-Circuit Impedance. An adequately rated one-megohm (minimum) resistor must be in series with the screen-terminal lead. Capacitance to ground (or elsewhere) from the section of the lead between the resistor and the screen terminal must be very low. For this reason, this section of the lead must be unshielded, must be no more than about one foot long, and must have no capacitors connected to it. The resistor should be rated at 2 watts and an end-to-end voltage of 7500 volts.

Failure to include this resistor almost invariably results in tube damage. Damage usually consists of an open internal screen connection caused by excessive screen current. When attempts are made to operate such tubes, no light is observed coming from the phosphor screen. Mechanical damage to the phosphor screen can often be observed in non-operating tubes.

Collector-Circuit Impedance. A 10,000 ohm (minimum) resistor must be in series with the lead to the collector terminal. Capacitance to ground (or elsewhere) from the section of the lead between the resistor and the collector terminal must be very low. For this reason, this section of the line must be unshielded, must be no more than about 3 feet long, and must have no capacitors connected to it. The resistor, to be protected in the event of a collector short circuit, should be rated for service at 10 watts and 500 volts.

Failure to include this resistor occasionally results in permanent damage to the storage surface due to excessive collector current. This damage is local in extent and appears in the display as small permanent bright spots. However, not all bright spots are caused by omission of this resistor.

Excessive Writing-Beam Current Density. The writing-beam current density of any area of the storage grid should be no more than is necessary to write that area to saturated brightness during one scan of the writing beam. Excessive writing-beam current density can permanently damage the storage surface.

Such damage ordinarily is local in extent and appears as permanent light or dark areas or spots in the display, coincident with areas struck by the excessive writing beam. In severe cases, mechanical damage to the phosphor screen can be observed on the face of the non-operating tube.

Under ordinary operating conditions, sufficient latitude exists in the maximum ratings so that a small degree of excessive writing-beam current density does not cause damage, unless prolonged for several hours. Nevertheless, it is strongly recommended that writing-beam current never be greater than that required for a given application.

During the operation of display-storage tubes, certain situations may arise that can quickly cause excessive writing-beam current density and consequent damage. These situations and safeguards against them are described below.

Failure of Scanning. Failure of scanning while the writing beam is turned on results in excessive writing-beam current density which often results in localized permanent storage-grid damage. Provision should be made to cut off the writing-beam current automatically in case of a scanning failure. The writing-beam current can be cut off by an electronic switch which applies -200 volts bias to grid No. 1 of the writing gun. This switch should be actuated by a portion of the scanning voltages applied to both sets of deflecting electrodes.

Loss of Bias. Loss of writing-gun control-grid bias, or loss of blanking, which causes the writing-gun control grid to be at or near zero bias, will result in excessive writing-beam current which may result in localized permanent damage to the storage grid.

Turning on Equipment. In some cases, the order in which voltages are applied to display-storage tubes when equipments are turned on can give rise to a situation of "no bias" or "no scanning". If writing-gun high voltage is applied before writing-gun bias, a zero-bias condition will exist. If writing-gun high voltage is applied before the writing-gun deflection voltages, a "no scanning" condition will exist. In these cases, damage as described above can occur. It is obvious that an extremely serious condition exists when the writing-gun high voltage is applied before either bias or deflection voltages.

In some equipments, the application of bias to the writing-gun control grid is delayed because of high impedance in the control-grid-to-bias-supply return circuit. One way to avoid this condition is to use a time-delay relay, operating from the writing-gun high-voltage switch, to connect the writing-gun control grid to a low-impedance point of the bias supply at a bias voltage sufficiently great to cut off the writing-gun beam until after the high voltage is applied.

To avoid a condition of runaway charging and possible tube damage, it is necessary that the viewing beam be operating before the writing beam is turned on. Allow the viewing-gun heater to reach operating temperature, and allow the viewing-gun beam current to reach normal operating value before turning on the writing-gun beam current. Furthermore, always keep the viewing-gun beam on till the writing beam is turned off.

Runaway Charging. A condition of runaway charging of the storage grid may result if the writing beam is allowed to land on the storage grid with the viewing beam turned off, if the writing beam is incident on an area of the storage grid not covered by the viewing beam, or even though the viewing beam is turned on if the current density in the writing beam exceeds that in the viewing beam. Such a runaway condition can occur because of the non-equilibrium writing process involved.

Because the electrons in the writing beam land with an energy such that the secondary-emission ratio of the storage-grid surface is greater than unity, this surface charges positively toward collector potential. Normally, the landing on the storage grid of the viewing-beam electrons keeps any portion of the storage-grid surface from charging above viewing-gun cathode potential. When this limiting action of the viewing beam is not present, the storage-grid surface may charge under the action of the writing beam to a value such that sparking occurs through the insulating layer between the storage-grid surface and the backplate. This sparking is observed as random bright flashes on the screen. In the event of sparking, permanent damage (loss of the ability to store a signal in localized areas) to the storage grid may result. Such damage can sometimes be avoided if the writing process is quickly stopped.

Reduced Viewing-Beam Diameter. In many display-storage tubes, the application of certain ranges of voltage to the viewing-gun grids will cause the viewing beam to be focused into a small spot. In this condition, the viewing beam is quite intense and can change the secondary-emission properties of the storage grid in the bombarded area. The voltage ranges assigned to the various viewing-gun grids in the technical bulletins under Maximum Ratings are chosen so that the viewing-beam current cannot be focused into a small spot.

In summary, the following precautions must be followed to protect the display-storage tube from inadvertent damage—

1. Do not exceed maximum ratings.
2. Be sure to include the screen resistor.
3. Be sure to include the collector resistor.
4. Do not apply excessive writing-beam current density.
5. Protect against scanning failure.
6. Protect against loss of bias.
7. Apply voltages to tube in correct order.
8. Never write unless viewing beam is on.
9. Stay within recommended viewing-grid voltage ranges.

GENERAL CONSIDERATIONS

Handling. The display-storage tube should preferably be transported or handled with the face up. Care should be taken to prevent knocking or bumping the bulb terminals. Such rough treatment may cause either immediate or delayed cracking of the metal-glass seals.

Support. Display-storage tubes which are not provided with an integral magnetic shield may be mounted by using a padded clamp around the neck of the tube and by sponge-rubber supports around the tube, except near the bulb caps. The tube should not be supported by the base or socket. Support for display-storage tubes having an integral magnetic shield is generally effected by using padded clamps around the neck and large diameter of the tube unless otherwise specified in the technical bulletins.

Supporting systems for "ruggedized" display-storage tubes should take into consideration mounting arrangements that will take full advantage of the environmental ratings of the tube.

Shielding. Magnetic shielding, if not integral in the display-storage tube, should always be provided to prevent external fields from interfering with the required accurate control of the low-velocity viewing beam. A cylindrical shield of properly annealed high-permeability material about 1/16-inch thick is usually satisfactory. The integral shielding provided in some display-storage tubes is satisfactory for most applications.

Degaussing. Display-storage tubes supplied both with or without integral magnetic shields should be degaussed before being placed in operation. A degaussing coil suitable for use with 5-inch display-storage tubes may be made by winding 900 turns of No. 17 enameled wire on a 7-inch diameter form 2 inches long. After connecting the coil to a suitable supply line (220 vac, 60 cps), slowly (taking at least 30 seconds) pass the display-storage tube through the coil and then slowly withdraw it completely from the ac magnetic field. Repeat this procedure at least two times. The tube should be removed at least five feet distant from the coil before disconnecting the coil from the supply line.

Deflection Considerations for Electrostatic Types. As with conventional oscillograph tubes, balanced electrostatic-deflection circuits should be employed. Each pair of the deflecting electrodes should be operated at an average potential about the same as that of grid No. 4 of the writing gun.

Video-Drive Considerations. In most applications the information to be stored and displayed by the tube should be applied as a video signal to the control grid (grid No. 1) or cathode of the writing gun. The writing-gun control grid should never be more positive than necessary to write the display to saturated brightness for a given scanning speed and drive condition. In determining the writing-drive requirements, it should be remembered that writing is essentially a charge-depositing process. The instantaneous writing-beam current needed for saturated writing varies directly with the speed at which the writing beam is deflected across the storage grid and varies inversely with the number of times a given storage element is written upon in one complete scan period.

The high voltages at which display-storage tubes operate may be very dangerous. Great care should be taken in the design of apparatus to prevent the operator from coming in contact with the high voltages. Safety precautions include the enclosing of high-potential terminals and the use of interlocking switches to break the primary circuit of the power supply when access to the equipment is desired.

In the use of high-voltage tubes, it should always be remembered that high voltages may appear at normally low-potential points in the circuit as a result of capacitor breakdown or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned off, and both terminals of any capacitors grounded.

The Use of Safety Glasses. It is recommended that shatter-proof protective glasses be worn when handling display-storage tubes having a diameter greater than 5 inches to help protect operators against tube implosion should the tube be accidentally struck.

REFERENCES

MIT Radar School Staff, PRINCIPLES OF RADAR, McGraw-Hill Book Co., Inc.

M. Knoll and B. Kazan, STORAGE TUBES AND THEIR BASIC PRINCIPLES, John Wiley and Sons, Inc.

M. Knoll, P. Rudnick, and H.O. Hook, *Viewing Storage Tube with Halftone Display*, RCA REVIEW, Vol. 14, No. 4, December 1953.

M. Knoll, H.O. Hook, and R.P. Stone, *Characteristics of a Transmission Control Viewing Storage Tube with Halftone Display*, PROC. I.R.E., Vol. 42, No. 10, October 1954.

M. Knoll and B. Kazan, *Viewing Storage Tubes*, ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS, Vol. VIII, 1956, Academic Press, N.Y., pp. 448-501.

R.P. Stone, *Use of the Potential Shift Diagram for Analysis of the Operation of Display-Storage Tubes*, PROC. NATIONAL ELECTRONICS CONFERENCE, Vol. XIII, 1957.

RCA

RCA electron tube ANNOUNCEMENT

A NEW TUBE..... AN IMPROVED TUBE..... SPECIAL INFORMATION

Tech Pubs
W Dunham

RADIO CORPORATION OF AMERICA
RCA INTERNATIONAL DIVISION
HARRISON, NEW JERSEY

LICENSEE SERVICE

November 15, 1960

RCA-7293-A

NEW FIELD MESH IMAGE ORTHICON
FEATURING "ANTI-GHOST" IMAGE-SECTION DESIGN

Gentlemen:

The new RCA-7293-A 3" image orthicon camera tube promises to set new black-and-white TV-camera standards for quality and versatility. The 7293-A is unilaterally interchangeable with the 7293.

The use of field-mesh design in this tube produces pictures having a very flat blemish-free background; eliminates the problem of "port-hole" or dark corners in the picture; greatly improves the sharpness in the corners of the picture; and eliminates troublesome white-edge effects due to scanning beam bending.

One of the additional important features of the 7293-A is the anti-ghost image section designed to suppress the annoying highlight flare or "ghost" that can occur beside brightly illuminated areas when the tube is operated "over the knee" in black-and-white cameras.

This tube will fill requirements for a high-quality black-and-white camera tube for indoor or outdoor service in present cameras, and satisfy the demand for higher quality pictures for recording purposes.

Additional features of the 7293-A include:

1. A suppressor grid designed to provide a blemish-free background and to maintain a low level of noise in the output.
2. A high-gain first dynode for high signal output.
3. Tight limits on these important performance characteristics:
    * Signal-to-noise ratio.
    * Landing or highlight uniformity.
    * Shading or background uniformity.
    * Resolution (Amplitude response).
4. RCA's traditionally high sensitivity and long life.

A technical bulletin for the 7293-A is being prepared and will be sent to you when available.

Very truly yours,

R F Simokat

R. F. SIMOKAT
Licensee Service

RFS:mlm

7293-A

IMAGE ORTHICON

Magnetic Focus
Magnetic Deflection

Anti-Ghost Image-Section Design
For Outdoor and Studio
Black-and-White TV Cameras

3"-Diameter Bulb
15.20" Length

RCA-7293-A is an image orthicon type of television camera tube intended for both outdoor and studio pickup. It has exceptionally high sensitivity combined with a spectral response approaching that of the eye. The 7293-A is very stable in performance at all incident light levels on the scene ranging from bright sunlight (several thousand footcandles) to a deep shadow (one footcandle or less). Commercially acceptable pictures can be obtained at incident light levels greater than about 10 footcandles. The sensitivity of the 7293-A is equivalent to photographic film having an ASA exposure index of 8000.

The image section of the 7293-A is designed especially to provide proper geometry and to suppress highlight flare or "ghost" that may occur when the 7293-A is operated with picture-highlight areas substantially above the "knee" of the light transfer characteristic. Other features include the use of a field-mesh which improves corner shading and geometry as well as permitting a sharp black-to-white transition without spurious effects. The use of a suppressor grid maintains at a low level the noise component in the output signal and also provides a smooth, blemish-free background. An additional feature of the 7293-A is a high-gain first dynode that assures an output-signal level well above the noise level of subsequent amplifier stages.

The photocathode utilized in the 7293-A is characterized by a spectral response having high blue sensitivity, high green sensitivity, good red sensitivity, and practically no infrared sensitivity. This latter characteristic of the response prevents any color-masking by infrared, and thus permits gray-scale rendition of colors in nearly their true tonal gradation.

DATA

General:

Heater, for Unipotential Cathode:
Voltage (AC or DC). . . . . 6.3 ± 10% volts
Current at 6.3 volts. . . . . 0.6 ampere
Direct Interelectrode Capacitance (Approx.):
Anode to all other electrodes . . . 12 pf
Spectral Response S-10
Wavelength of Maximum Response. . . 4500 ± 300 angstroms
Photocathode, Semitransparent:
Rectangular Image (4 x 3 aspect ratio):
Useful size of. . . . . 1.8" max. Diagonal

Note: The size of the optical image focused on the photocathode should be adjusted so that its maximum diagonal does not exceed the specified value. The corresponding electron image on the target should have a size such that the corners of the rectangle just touch the target ring; a condition that may be achieved in some camera designs with a 1.6" diagonal image on the photocathode.

Orientation of. . . . . . Proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through center of faceplate and pin 7 of the shoulder base. The horizontal and vertical scan should preferably start at the corner of the raster nearest pin 6 of the shoulder base.

Focusing Method . . . . .Magnetic
Deflection Method . . . . .Magnetic
Overall Length. . . . . 15.20" ± 0.25"
Greatest Diameter of Bulb . . . . 3.00" ± 0.06"
Shoulder Base . . . . Keyed Jumbo Annular 7-Pin
End Base. . . . . .Small-Shell Diheptal 14-Pin Base (JEDEC No.B14-45)
Operating Position. . . . . .The tube should never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with the base up makes an angle of less than 20° with the vertical.

Contents

RADIO CORPORATION OF AMERICA
Electronic Components and Devices, Lancaster, Pa.

7293-A 7-63
Printed in U.S.A.

Weight (Approx.)	1 lb 2 oz
Minimum Deflecting-Coil Inside Diameter	2-3/8"
Deflecting-Coil Length	5"
Focusing-Coil Length	10"
Alignment Coil:	
Length	15/16"
Position on Neck	Centerline of coil located 8.5" from the flat area of the jumbo annular base.
Photocathode Distance Inside End of Focusing Coil	1/2"

Maximum Ratings, *Absolute-Maximum Values:*[a]

PHOTOCATHODE:		
Voltage	-700 max.	volts
Illumination	50 max.	fc
OPERATING TEMPERATURE:		
Of any part of bulb	65 max.	°C
Of bulb at large end of tube (target section)	35 min.	°C
TEMPERATURE DIFFERENCE:		
Between target section and any part of bulb hotter than target section	5 max.	°C
GRID-No.6 VOLTAGE	-700 max.	volts
TARGET VOLTAGE:		
Positive value	10 max.	volts
Negative value	10 max.	volts
GRID-No.5 VOLTAGE	150 max.	volts
GRID-No.4 VOLTAGE	350 max.	volts
GRID-No.3 VOLTAGE	400 max.	volts
GRID-No.2 & DYNODE-No.1 VOLTAGE	350 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value	125 max.	volts
Positive bias value	0 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	10 max.	volts
ANODE-SUPPLY VOLTAGE[b]	1350 max.	volts
VOLTAGE PER MULTIPLIER STAGE	350 max.	volts

Typical Operating Values:[c]

Photocathode Voltage (Image Focus)[d]	-325 to -475	volts
Grid-No.6 Voltage (Accelerator)—Approx. 65% to 75% of photocathode voltage[e]	-210 to -360	volts
Target-Cutoff Voltage[f]	-3 to +1	volts
Grid-No.5 Voltage (Decelerator)	0 to 40	volts
Grid-No.4 Voltage (Beam Focus)[d]	140 to 180	volts
Grid-No.3 Voltage[g]	260 to 300	volts
Grid-No.2 & Dynode-No.1 Voltage	300	volts
Grid-No.1 Voltage for Picture Cutoff	-45 to -115	volts
Dynode-No.2 Voltage	600	volts
Dynode-No.3 Voltage	800	volts
Dynode-No.4 Voltage	1000	volts
Dynode-No.5 Voltage	1200	volts
Anode Voltage	1250	volts
Target Temperature Range	35 to 45	°C
Minimum Peak-to-Peak Blanking Voltage	5	volts
Field Strength at Center of Focusing Coil (Approx.)[h]	75	gausses
Field Strength of Alignment Coil	0 to 3	gausses

Performance Data:

With conditions shown under Typical Operating Values and with camera lens set to bring picture highlights 1 stop above the "knee" of the light transfer characteristic.

	Min.	*Average*	*Max.*	
Cathode Radiant Sensitivity at 4500 angstroms	–	0.028	–	μa/μw
Luminous Sensitivity (2870° K)	30	60	–	μa/lm
Anode Current (DC)	–	30	50	μa
Signal-Output Current (Peak to Peak)	5	–	30	μa
Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current for Bandwidth of 4.5 Mc	35:1	40:1	–	
Photocathode Illumination at 2870° K Required to Reach "Knee" of Light Transfer Characteristic	–	0.010	0.028	fc
Amplitude Response at 400 TV Lines per Picture Height (Per cent of large-area black to large-area white)[j]	40	60	–	%
Limiting Horizontal Resolution	500	–	–	TV Lines
Uniformity:[k]				
Ratio of Shading (Background) Signal to Highlight Signal	–	–	0.15	
Decrease from Peak Highlight Signal Level of Signal from any Point on Scanned Area of Target	–	–	25	%

[a] The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[b] Dynode-voltage values are shown under *Typical Operating Values.*

[c] With 7293-A operated in RCA-TK-11 or -TK-31 camera. Other cameras may require slightly different voltage ranges.

[d] Adjust for best focus.

[e] For minimum highlight flare or "ghost" the grid-No.6 voltage should be 73% of the photocathode voltage.

[f] Normal setting of target voltage is +2 volts from target cutoff. The target supply voltage should be adjustable from -3 to +5 volts.

[g] Adjust to give the most uniformly shaded picture near maximum signal.

[h] Direction of current should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.

[j] Measured with amplifier having flat frequency response.

[k] With uniform illumination on photocathode.

SET-UP PROCEDURE

The *set-up procedure* used for field-mesh type image orthicons like the 7293-A differs in the following respects from that to be used for image orthicons that do not employ field-mesh design. First, the deflecting yoke used with the 7293-A must be rotated to produce a picture having proper horizontal scan. Secondly, because the dynode aperture of the 7293-A cannot be brought into focus different alignment techniques must be used. Thirdly, the 7293-A *may not* be operated on certain grid-No.4 voltage loops because of severe mesh-beat patterns that result.

To obtain optimum performance from the 7293-A the following set-up procedure should be carefully followed.

Before the proper voltages are applied to the tube as indicated under *Typical Operating Values*, the lens should be uncapped and the lens iris opened. *This is a very important step for this type of image orthicon.* The proper voltages should then be applied to the 7293-A, and the grid-No.1 voltage should immediately be adjusted to produce a small amount of beam current. This procedure will prevent the mesh from being electrostatically pulled into contact with the glass disc. Make certain that the deflection circuits are functioning properly to cause the electron beam to scan the target. Adjust the deflection circuits so that the beam will "overscan" the target, i.e., so that the area of the target scanned is greater than its sensitive area. This procedure during the warming-up period is recommended to prevent burning on the target a raster smaller than that used for on-the-air operation. Note that overscanning the target results in a smaller-than-normal picture on the monitor. The lens should then be capped and the tube should be allowed to warm up for 15 minutes to one-half hour before use or before other adjustments are made.

Next, uncap the lens and partially open the lens iris. Increase the target voltage until information appears on the monitor. Then adjust beam focus, image focus, and optical focus until detail can be discerned in the picture. Adjust alignment-coil-current controls until picture response is maximum. If picture appears in negative contrast, increase the beam current. Further adjust the alignment-coil current so that the center of the picture does not move when the beam-focus control (grid-No.4) is varied, but simply goes in and out of focus. During alignment of the beam, and also during operation of the tube, always keep the beam current as low as possible to give the best picture quality and also to prevent excessive noise.

Next, focus the camera on a test pattern. The camera-to-test pattern distance should be set so that the corners of the test-pattern image just touch the inside of the target ring. The deflection circuits are next adjusted so that the entire test pattern just fills the TV raster. The target voltage is then advanced or reduced to the point where a reproduction of the test pattern is just discernible on the monitor. This value of target voltage is known as the "target-cutoff voltage". The target voltage should then be raised exactly two volts above the cutoff-voltage value, and the beam-current control adjusted to give just sufficient beam current to discharge the highlights.

Then adjust the lens to produce best optical focus, and the voltage on the photocathode as well as the voltage on grid No.4 to produce the sharpest picture. To prevent mesh-beat problems, the voltage on grid No.4 should be adjusted to a value between 150 and 180 volts.

Proper adjustment for suppression of highlight flare or "ghosts" and proper geometry is obtained when the grid-No.6 voltage is accurately set at 73 per cent of the photocathode voltage. This adjustment may be effected by positioning a small bright spot of light on the edge of the field to be viewed and then adjusting the grid-No.6 voltage so that the "ghost" that appears on the viewing monitor disappears as the image section is brought into sharpest focus. Improper adjustment is evident when a light spot that is observed on the right edge of the viewing monitor produces a "ghost" that appears above the spot and when a light spot observed on the left edge of the viewing monitor produces a "ghost" that appears below the spot.

Grid No.5 should then be adjusted to produce the best compromise between high signal output in the picture corners and best geometry. Best geometry is evident by a rectangular raster and the absence of "S" distortion of straight lines.

After adjustment of the image section voltages, grid-No.3 voltage should be set for maximum signal output. The deflecting yoke and the 7293-A should be rotated, if necessary, so that the horizontal scanning of the camera is parallel to the horizontal plane of the scene.

Finally, readjust the target voltage so that it is accurately set to 2 volts above target cutoff. With the lens open, the lens iris should be opened to one or two lens stops beyond the point where the highlights of the scene reach the knee of the light transfer characteristic.

The information shown on the following pages under *Operating Considerations*, *Camera-Design Considerations*, *Principles of Operation*, and *Dos and Don'ts* is similar to that recommended for other 3-inch image orthicons employing field-mesh design.

OPERATING CONSIDERATIONS

The 7293-A has two complementary guides for inserting the tube correctly in the annular socket, i.e., the large pin (No.7) on the annular base, and the white radial line on the face of the bulb.

Installation of the 7293-A in the camera is accomplished by inserting the diheptal-base end of the tube through the coil assembly and then turning the tube until the annular-base pins, keyed by pin 7, can be inserted in the annular socket. Proper insertion aligns the white radial line on the face with center of the key-pin hole in the annular socket. The diheptal socket is then put on the 14-pin base.

Underscanning the target, i.e., scanning an area of the target less than its sensitive area, should never by permitted. Underscanning produces a larger-than-normal picture on the monitor. If the target is underscanned for any length of time, a permanent change in target-cutoff voltage of the underscanned area takes place with the result that the underscanned area thenceforth is visible in the picture when full-size scanning is restored.

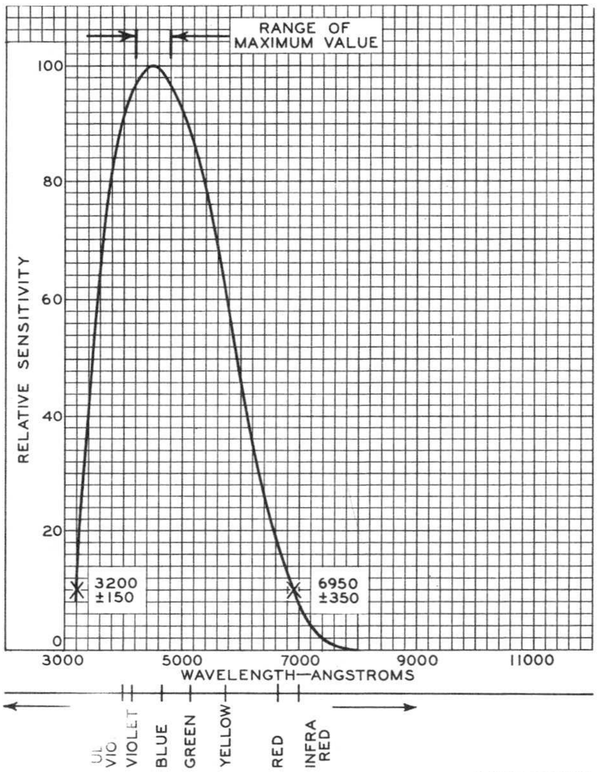


Fig. 1 - Spectral Sensitivity Characteristic of Type 7293-A which has S-10 Response. Curve is shown for Equal Values of Radiant Flux at All Wavelengths.

During standby operation the lens of the camera should always be closed or capped. An effective method of performing the same end result is to cut off the photocathode voltage by means of a switch. The camera will instantly be ready for operation when the photocathode voltage is again turned on. *Never turn off the beam during camera warm up or during standby operation.*

The light transfer characteristics of the 7293-A change for different illumination levels (see Reference 3). The basic light transfer characteristic of the 7293-A is shown in Fig.2. The light values shown are applicable only for the indicated kinds of illumination incident on the photocathode. This curve is representative only for small-area highlights.

Sensitivity and Illumination: The image orthicon is an ultra-sensitive device exceeding in relative sensitivity most high-speed photographic film. When related to photographic film and compared at shutter speeds of 1/60 second which is the field rate of the television system, the 7293-A with proper illumination will have an equivalent ASA exposure index of 8000. This equivalent film-speed rating can be used in conjunction with a photographic exposure meter to determine the approximate light level or lens-stop setting necessary for operating the 7293-A.

The illumination on the photocathode of the 7293-A in relation to the scene illumination, can be determined by the following relationship:

$$I_s = \frac{4f^2 \, I_{pc} \, (m+1)^2}{TR}$$

where

I_s = scene illumination in footcandles

f = f-number of lens

I_{pc} = photocathode illumination in footcandles

m = linear magnification from scene to target

T = total transmission of lens

R = reflectance of principal subject in scene

Except for very close shots, the linear magnification (m) from scene to target may be neglected.

For example, assume that the lens is f:11 having a transmission (T) of 80%, that the photocathode illumination is 0.020 footcandle, and that the scene to be televised has a highlight reflectance (R) of 75%.

Then,

$$I_s = \frac{4 \times 11^2 \times 0.020}{0.8 \times 0.75} = 16 \text{ footcandles}$$

The exact illumination for each 7293-A as finally set up on the scene should be determined

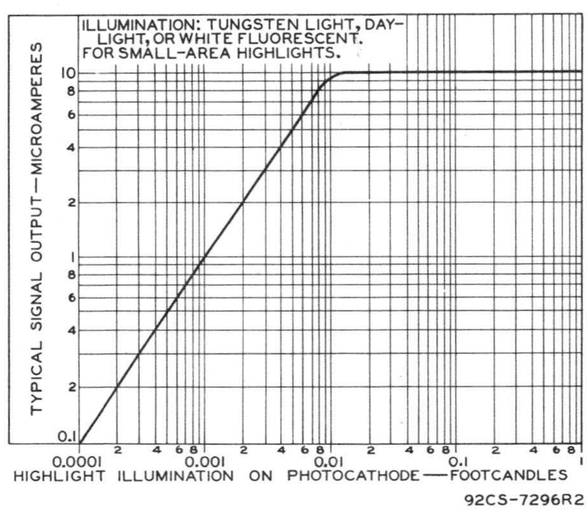


Fig. 2 - Basic Light Transfer-Characteristic of a Typical Type 7293-A.

by observing the video waveform on an oscilloscope. First adjust the lens setting of each camera to that level of light necessary to reach the knee of the light transfer characteristic.

The camera lens is then normally set to bring picture highlights one stop above the knee of the transfer characteristic.

For very high illumination or for individual tubes with exceptionally high photocathode sensitivity, it may not be possible to stop the lens down far enough to reduce the highlight illumination on the photocathode to a value near the knee of the transfer characteristic. When such a condition is encountered, the use of a Wratten neutral filter selected to give the required reduction in illumination is recommended. Ordinarily, two filters—one having 10% transmission and the other 20%—will give sufficient choice. Such filters with lens-adapter rings can be obtained at photographic-supply stores.

The low illumination level needed on the photocathode of the 7293-A makes it necessary that no stray light from without or within the camera falls on the face of the tube.

Retention of a scene by the 7293-A sometimes called a "sticking picture", may be experienced if the 7293-A is allowed to remain focused on a stationary bright scene, or if it is focused on a bright scene before reaching operating temperature in the range from 35° to 45° C. Often the retained image will disappear in a few seconds, but sometimes it may persist for long periods before it completely disappears. A very persistent image can generally be removed by focusing the 7293-A on a clear white screen and allowing it to operate for a period of time with an illumination of about 1 footcandle on the photocathode.

To minimize retention of a scene, it is recommended that the 7293-A always be allowed to warm up in the camera for 1/4 to 1/2 hour with the lens iris closed and with a slight amount of beam current. Never allow the 7293-A to remain focused on a stationary bright scene, and never use more illumination than is necessary.

Occasionally, a *white spot* which does not change in size when the beam-focus voltage is varied, may be observed in the center of the picture. Such a spot, especially if it is visible on the monitor with the camera lens capped, is probably an ion spot. If the spot begins to grow in size with continuous operation, the 7293-A should be removed from service at once, and returned for re-processing. Continued operation of an image orthicon with an ion spot will eventually damage the target permanently.

New 7293-A's should be placed in service immediately upon receipt. They should be operated for several hours before being set aside as spares.

Spare 7293-A's should be placed in service for several hours at least once a month in order to keep them free from traces of gas which may be liberated within the tube during prolonged storage.

CAMERA-DESIGN CONSIDERATIONS

Considerations in the design of cameras utilizing 7293-A's include provision for: positioning the axis of the 7293-A to align with the electrical axis of its focusing-coil field; positioning the deflecting yoke at the proper point along the axis of the tube; centering the deflecting yoke around the axis of its associated focusing coil; and positioning each 7293-A at the same relative position in its associated focusing-coil field.

The camera should be designed so that the 7293-A is positioned in such a manner that the start of scan of the raster is on the same side of the tube as pin 7 of the jumbo annular base. Furthermore, start of scan should begin at the corner of the scanned area that is located clockwise from pin 7 of the jumbo annular base when the tube is viewed from the faceplate end.

The *deflecting yoke and focusing coil used with the 7293-A* must incorporate means for preventing the magnetic field produced by the deflecting yoke from extending into the image section of the tube. Unless proper shielding is provided, cross-talk from the deflecting yoke into the image section will cause the electron image to "jitter". This jitter produces a loss of picture sharpness. It is common practice to enclose the focusing coil in a cylindrical magnetic shield. Additional shielding can be provided by fitting the inside portion of the focusing coil which is directly over the image section of the 7293-A with a copper cylinder having a length of approximately 2-1/4" and a wall thickness of 1/32".

If the above camera-design considerations are followed, the optical focus, the image size, and the centering from tube to tube will be very uniform.

To utilize the *resolution capability* of the 7293-A in the horizontal direction with the standard scanning rate of 525 lines, it is necessary to use a video amplifier having a bandwidth of at least 6 megacycles.

Even with a wide-band amplifier, the resolution may be limited in the image section by "cross-talk" caused by the scanning fields. Unless prevented by proper shielding from extending into the image section, these fields will cause the electron image on the target to move at scanning frequency. As a result, the picture will lack definition.

A *blanking signal* should be supplied to the target to prevent the electron beam from striking the target during the return portions of the horizontal and vertical deflecting cycles. Unless this is done, the camera-tube return lines will appear in the received picture.

The blanking signal is a series of negative voltage pulses. The voltage between pulses must be constant to prevent fluctuation of the target voltage. During the blanking period, the full beam current without video-signal modulation is returned to the multiplier and its multiplied output flows through the load resistance. Excessive amounts of blanking voltage applied to the target will impair resolution, because during retrace the target is out of focus to the continuously flowing photocathode current. A desirable amount of target blanking is 6 volts peak to peak.

Shading may be required even with optimum adjustment of voltage on grid No.3 in order to obtain a uniformly shaded picture. A sawtooth waveform of adjustable amplitude and polarity at both the vertical- and horizontal-scanning frequency should be provided for insertion in the video amplifier to aid in obtaining a flat background. The shading signal should be introduced in the amplifier after clamping is performed, because clamping circuits will remove the vertical-frequency shading component if added previous to the clamp-circuit location.

Failure of scanning even for a few minutes when light is incident on the photocathode may permanently damage the surface of the target. The damaged area shows up as a spot or line in the picture during subsequent operation.

To avoid damaging the 7293-A during scanning failure, provision should be made to prevent automatically the scanning beam from reaching the target. The scanning beam can be prevented from reaching the target by (1) cutting off the scanning beam, or (2) making the target sufficiently negative. The scanning beam can be cut off by a relay which applies -115 to -125 volts bias to grid No.1. The target can be made sufficiently negative by a relay which applies a bias of at least -10 volts to it. Either relay is actuated by a tube which is controlled by a portion of the scanning pulse voltage developed across either the horizontal or the vertical deflecting coils, or both. It is important to insure that the horizontal scanning pulse and the vertical scanning pulse should each independently actuate the relay in case either one fails.

The *operating temperature* of any part of the glass bulb should never exceed 50° C, and no part of the bulb at the large end of the tube (image section) should ever fall below 35° C during operation. For best results, it is recommended that the temperature of the entire bulb be held between 35° and 45° C. Operation at too low a temperature will be characterized by the appearance of a rapidly disappearing "sticking picture" of opposite polarity from the original when the picture is moved. Operation at too high a temperature will cause loss of resolution and possibly permanent damage to the tube. The loss of resolution is caused by the decreasing resistivity of the target glass disc with increasing temperature. As a result, lateral leakage of the image charge occurs. Resolution is regained by waiting for the temperature to drop below 50° C. *No part of the bulb should run more than 5° C hotter than the image section* to prevent cesium migration to the target. Such migration will result in loss of resolution and in probably permanent damage to the tube. Like other photosensitive devices employing cesium, the 7293-A may show fluctuations in performance from time to time. Strict observance of the above recommendations with respect to operating temperature will not completely eliminate these variations but will greatly improve the stability of the characteristics during the life of the tube.

A mask having a diagonal or diameter of 1.8 inches should always be used on the photocathode to reduce the amount of light reaching unused parts of the photocathode.

The *optical system* used with the 7293-A should be designed according to basic optical principles and should incorporate control of the amount of light entering the television camera lens. This control may consist of an iris or an iris and suitable neutral-density filters. The entire optical system should have all inside surfaces finished in mat black to prevent internal reflections from reaching the photocathode. Under almost all conditions, the use of a lens shade is beneficial.

PRINCIPLES OF OPERATION

The 7293-A has three sections—an image section, a scanning section, and a multiplier section.

Image Section

The image section contains a semitransparent photocathode on the inside of the faceplate, a grid (grid No.6) to provide an electrostatic accelerating field, and a target which consists of a thin glass disc with a fine mesh screen very closely spaced to it on the photocathode side. Focusing is accomplished by means of a magnetic field produced by an external coil, and by the proper selection of photocathode voltage and grid-No.6 voltage.

Light from the scene being televised is picked up by an optical system and focused on the photocathode which emits electrons from each illuminated area in proportion to the intensity of the light striking the area. The streams of electrons are focused on the target by the magnetic and accelerating fields.

On striking the target, the electrons cause secondary electrons to be emitted by the glass. The secondaries thus emitted are collected by the adjacent mesh screen which is held at a definite potential of several volts with respect to target-cutoff voltage. Therefore, the potential of the glass disc is limited for all values of light and stable operation is achieved. Emission of the secondaries leaves on the photocathode side of the glass a pattern of positive charges which corresponds with the pattern of light from the scene being televised. Because of the thinness of the glass, the charges set up a similar potential pattern on the opposite or scanned side of the glass.

Scanning Section

The opposite side of the glass is scanned by a low-velocity electron beam produced by the electron gun in the scanning section. This gun contains a thermionic cathode, a control grid (grid No.1), and an accelerating grid (grid No.2). The beam is focused at the target by the magnetic field of an external focusing coil and the electrostatic field of grid No.4.

Deflection of the beam is accomplished by transverse magnetic fields produced by external deflecting coils.

Alignment of the beam from the gun is accomplished by a transverse magnetic field produced by external coils located at the gun end of the focusing coil.

By proper adjustment of potentials including that of grid No.5, the beam is caused to approach the target perpendicularly and with essentially zero velocity. The electrons stop their forward motion at the surface of the glass and are turned back and focused into a five-stage signal multiplier, except when they approach the positively charged portions of the pattern on the glass. When this condition occurs, they are deposited from the scanning beam in quantities sufficient to neutralize the potential pattern of the glass. Such deposition leaves the glass with a negative charge on the scanned side and a positive charge on the photocathode side. These charges neutralize each other by conductivity through the glass in less than the time of one frame.

The target end of the grid-No.4 cylinder is covered by a fine-mesh screen of high transmission. This screen, the *field mesh*, acts to increase the strength of the decelerating field immediately in front of the target. The increased strength of the field aids in causing the beam to approach the target perpendicularly at all points on the target. The enhanced field also prevents the charge pattern on the target from bending the beam away from its proper trajectory. The overall result of these two effects is to enable the 7293-A to produce a picture that is relatively free of unwanted bright edges or overshoots at the boundary of brightly illuminated portions of a scene. The field mesh also defocuses the return beam so that the texture of the first dynode does not appear in the background of the picture.

Multiplier Section

The return beam is directed to the first dynode of a five-stage electrostatically focused multiplier. This utilizes the phenomenon of secondary emission to amplify the modulated beam current more than 500 times. The electrons in the beam impinging on the first-dynode surface produce many other electrons. These secondary electrons are then directed to the second dynode and knock out more new electrons.

Grid No.3 facilitates a more complete collection by dynode No.2 of the secondaries from dynode No.1. The multiplying process is repeated in each successive stage, with an ever-increasing stream of electrons until those emitted from dynode No.5 are collected by the anode and constitute the current utilized in the output circuit. The multiplier section amplifies the modulated beam more than 500 times.

The signal-to-noise ratio of the output signal from the 7293-A is high. The gain of the multiplier is such as to raise the output signal sufficiently above the noise level of the video amplifier stages so that they contribute no noise to the final video signal. The signal-to-noise ratio of the video signal, therefore, is determined only by the random variation in the quantity of the electrons in the modulated electron beam.

DOS and DON'TS on Use of RCA-7293-A

Here are the "dos"

1. Allow the 7293-A to warm up prior to operation.
2. Hold temperature of the 7293-A within operating range.
3. Make sure alignment coil is properly adjusted.
4. Adjust beam-focus control for best usable resolution.
5. Condition spare 7293-A's by operating several hours once each month.
6. Determine proper operating point with target voltage adjusted to exactly 2 volts above target cutoff.
7. Cap lens during standby operation.
8. Uncap lens before voltages are applied to the 7293-A.

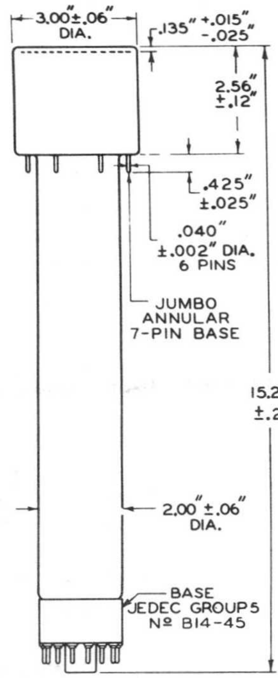
Here are the "don'ts"

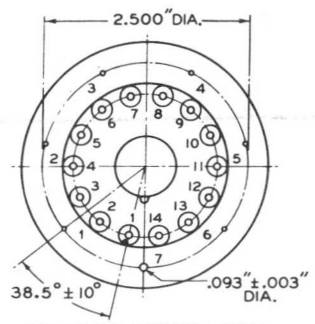
1. Don't force the 7293-A into its shoulder socket.
2. Don't operate the 7293-A without scanning.
3. Don't underscan target.
4. Don't focus the 7293-A on a stationary bright scene.
5. Don't operate a 7293-A having an ion spot.
6. Don't use more beam current than necessary to discharge the highlights of the scene.
7. Don't turn off beam while voltages are applied to photocathode, grid No.6, target, dynodes, and anode during warmup or standby operation.

REFERENCES

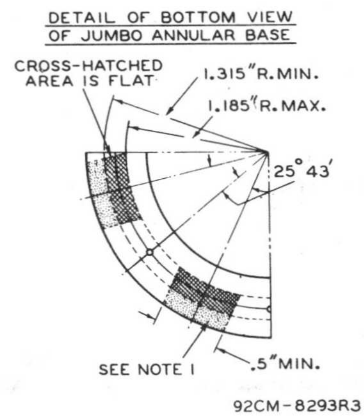
1. R. B. Janes, R. E. Johnson, and R. S. Moore, *"Design and Performance of Television Camera Tubes"*, RCA Review, June, 1949.
2. R. B. Janes, R. E. Johnson, and R. R. Handel, *"A New Image Orthicon"*, RCA Review, December, 1949.
3. R. B. Janes and A. A. Rotow, *"Light Transfer Characteristics of Image Orthicons"*, RCA Review, September, 1950.
4. A. A. Rotow, *"Reduction of Spurious Signals in Image Orthicon Cameras"*, Broadcast News, February, 1955.
5. R. G. Neuhauser, *"Sensitivity and Motion Capturing Ability of Television Camera Tubes"*, Jour. of SMPTE, July, 1959.

DIMENSIONAL OUTLINE





ENLARGED BOTTOM VIEW



NOTE 1: DOTTED AREA IS FLAT OR EXTENDS TOWARD DIHEPTAL-BASE END OF TUBE BY 0.060" MAX.

ANNULAR BASE GAUGE

ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK CYLINDER WILL FIT FLAT-PLATE GAUGE WITH:

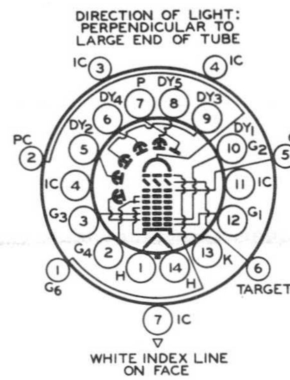
a. SIX HOLES HAVING DIAMETER OF 0.065" ± 0.001" AND ONE HOLE HAVING DIAMETER OF 0.150" ± 0.001". ALL HOLES HAVE DEPTH OF 0.265" ± 0.001". THE SIX 0.065" HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047". ALL HOLES ARE SPACED AT ANGLES OF 51°26' ± 5' ON CIRCLE DIAMETER OF 2.500" ± 0.001".

b. SEVEN STOPS HAVING HEIGHT OF 0.187" ± 0.001", CENTERED BETWEEN PIN HOLES, TO BEAR AGAINST FLAT AREAS OF BASE.

c. RIM EXTENDING OUT A MINIMUM OF 0.125" FROM 2.812" DIAMETER AND HAVING HEIGHT OF 0.126" ± 0.001".

d. NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200" ± 0.001".

BASING DIAGRAM
Bottom View



SMALL-SHELL DIHEPTAL 14-PIN BASE

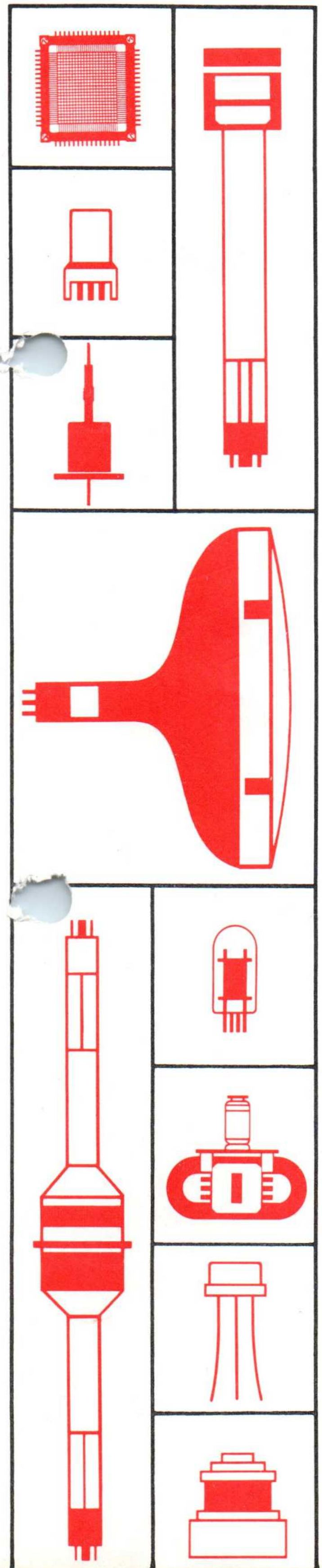
PIN 1:	HEATER	PIN 9:	DYNODE No.3
PIN 2:	GRID No.4 & FIELD MESH	PIN 10:	DYNODE No.1, GRID No.2
PIN 3:	GRID No.3	PIN 11:	INTERNAL CONNECTION—DO NOT USE
PIN 4:	INTERNAL CONNECTION—DO NOT USE	PIN 12:	GRID No.1
PIN 5:	DYNODE No.2	PIN 13:	CATHODE & SUPPRESSOR GRID
PIN 6:	DYNODE No.4	PIN 14:	HEATER
PIN 7:	ANODE		
PIN 8:	DYNODE No.5		

NOTE: In the tube symbol, the suppressor grid connected to the cathode, and the field-mesh grid connected to grid No.4, are intentionally without numbers to avoid upsetting industry practice of associating functional camera control knobs with specific grid numbers. For example, beam-focus control is generally associated with knob identified as G_4 (grid No.4).

KEYED JUMBO ANNULAR 7-PIN BASE

PIN 1:	GRID No.6	PIN 5:	GRID No.5
PIN 2:	PHOTOCATHODE	PIN 6:	TARGET
PIN 3:	INTERNAL CONNECTION—DO NOT USE	PIN 7:	INTERNAL CONNECTION—DO NOT USE
PIN 4:	INTERNAL CONNECTION—DO NOT USE		

NEW PRODUCT ANNOUNCEMENT



RADIO CORPORATION OF AMERICA

INTERNATIONAL DIVISION / HARRISON, N. J.
LICENSEE SERVICE

October 12, 1964

RCA-7293A/L - 3"-DIAMETER IMAGE ORTHICON HAVING NEWLY DEVELOPED LONG-LIFE TARGET AND ANTI-GHOST IMAGE SECTION

RCA is pleased to announce a newly developed long-life 3"-image orthicon. This tube utilizes a new type glass target which virtually eliminates the problem of image retention, or sticking - the cause of retirement of most image orthicons today. Another important improvement made possible by this new target is stability of sensitivity throughout the useful life of the tube. The 7293A/L incorporates all the excellent characteristics of the 7293A and is directly interchangeable with it in all cameras. The new tube will be generally available in January 1965 with limited quantities for sale until that date.

MAJOR FEATURES:

- New Long-Life Target
- Constant Target Gain and Resistivity
- Minimal "Sticking Picture" and Raster "Burn-In" Problems
- Stable Sensitivity Throughout Useful Tube Life
- Anti-Ghost Image-Section Design
- Direct Interchangeability with 7293A in All Cameras

APPLICATIONS: For TV cameras in outdoor and studio black-and-white television.

TECHNICAL BULLETIN: Detailed technical information on the 7293A/L is given in the attached data sheet.

Very truly yours,

R. F. Simokat
Licensee Service

This bulletin is to be used in conjunction with the bulletin for the RCA-7293A

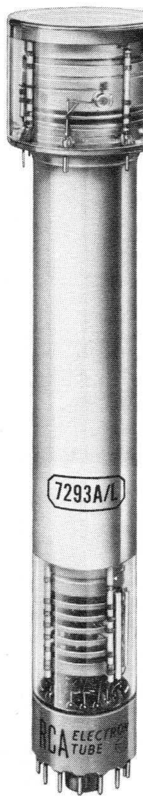
RCA-7293A/L
IMAGE ORTHICON

Magnetic Focus
Magnetic Deflection
3"-Diameter Bulb
15.20" Length

Long-Life Target, Anti-Ghost Image-Section Type Camera Tube for Outdoor and Studio Black-and-White Television

The 7293A/L is directly interchangeable with the 7293A in all cameras.

RCA-7293A/L is an image-orthicon type of television camera tube intended for outdoor and studio black-and-white TV pickup. It employs a sturdy, long-life, non-deteriorating, glass target that is characterized by high gain, resistance to "burn-in", and the absence of any granular structure. Because charge transportation through this target material is electronic rather than ionic as in ordinary glass targets, the electrical characteristics of the target, such as secondary emission and resistivity, are essentially constant and sensitivity of the 7293A/L is stable throughout life. Other important advantages of this target are that the undesirable characteristics of scene retention or "sticking picture" and raster "burn-in" due to underscanning are significantly reduced. The resistance of the 7293A/L to image "burn-in" provides a highly desirable operational feature because it is not necessary to use an orbiter or continually move the camera when focused on a stationary scene.



The paragraphs in the attached 7293A bulletin discussing *Underscanning the target* on pages 3 and 4 and *Rentention of a scene* on page 5 do not apply to the 7293A/L.

Features of the 7293A/L include:

- Sturdy, Long-Life, Non-Deteriorating Target.
- Constant Target Gain and Resistivity
- Minimal "Sticking Picture" and Raster "Burn-in" Problems
- Stable Sensitivity throughout Useful Tube Life
- Anti-Ghost Image-Section Design

DOS and DON'TS on Use of RCA-7293A/L

Here are the "dos"

1. Allow the 7293A/L to warm up prior to operation.
2. Hold temperature of the 7293A/L within operating range.
3. Make sure alignment coil is properly adjusted.
4. Adjust beam-focus control for best usable resolution.
5. Condition spare 7293A/L's by operating several hours once each month.
6. Determine proper operating point with target voltage adjusted to exactly 2 volts above target cutoff.
7. Uncap lens before voltages are applied to the 7293A/L.

Here are the "don'ts"

1. Don't force the 7293A/L into its shoulder socket.
2. Don't operate the 7293A/L without scanning.
3. Don't operate a 7293A/L having an ion spot.
4. Don't use more beam current than necessary to discharge the highlights of the scene.
5. Don't turn off beam while voltages are applied to photocathode, grid No.6, target, dynodes, and anode during warm-up or standby operation.

This bulletin is to be used in conjunction with the bulletin for the RCA-7295B

RCA-7295B/L
IMAGE ORTHICON

Magnetic Focus
Magnetic Deflection
4.500" Diameter
19.375" Length

Long-Life Target, Field-Mesh Type for High-Quality Black-and-White TV Cameras

The 7295B/L is directly interchangeable with the 7295, 7295A, and 7295B in all cameras.

RCA-7295B/L is a 4-1/2-inch diameter image orthicon type camera tube intended for high-quality black-and-white TV pickup in studio or outdoor service. The superior quality of the picture signal from the 7295B/L also permits the making of a series of successive recordings while still retaining excellent picture quality. It employs a stable, long-life glass target that is characterized by high gain, resistance to "burn-in", and the absence of any granular structure. The electrical characteristics of the target, such as secondary emission and resistivity, are essentially constant and sensitivity of the 7295B/L is stable throughout life because the conduction mechanism involved with transfer of charge through this target material is electronic rather than ionic as in ordinary glass targets.

Other important advantages of this target are that the undesirable characteristics of scene retention or "sticking picture" and raster "burn-in" due to underscanning are significantly reduced. The resistance of the 7295B/L to image "burn-in" provides a highly desirable operational feature because it is not necessary to use an orbiter or continually move the camera when focused on a stationary scene.

The paragraphs in the attached 7295B bulletin discussing *Underscanning the target* on page 5 and *Retention of a scene* on page 6 do not apply to the 7295B/L.

Features of the 7295B/L include:

- Stable, Long-Life Target
- Constant Target Gain
- Minimal "Sticking Picture" and Raster "Burn-in" Problems
- Stable Sensitivity throughout Useful Tube Life
- Microdamp Construction

DOS and DON'TS on Use of RCA-7295B/L

Here are the "dos"

1. Allow the 7295B/L to warm up prior to operation.
2. Hold temperature of the 7295B/L within operating range.
3. Make sure alignment coil is properly adjusted.
4. Adjust beam-focus control for best usable resolution.
5. Condition spare 7295B/L's by operating several hours once each month.
6. Determine proper operating point with target voltage adjusted to the desired voltage above target-cutoff.
7. Uncap lens before voltages are applied to the 7295B/L.

Here are the "don'ts"

1. Don't force the 7295B/L into its shoulder socket.
2. Don't operate the 7295B/L without scanning.
3. Don't operate a 7295B/L having an ion spot.
4. Don't use more beam current than necessary to discharge the highlights of the scene.
5. Don't turn off beam while voltages are applied to photocathode, grid No.6, target, dynodes, and anode during warm-up or standby operation.

RCA-7389B
IMAGE ORTHICON

Magnetic Focus
Magnetic Deflection

For High-Quality Black-and-White Studio TV Cameras,
Live Pickup, and Magnetic Tape Recording
Very High Signal-to-Noise Ratio
Excellent Resolution Capability

4.500" Diameter
19.375" Length

The 7389B is Unilaterally Interchangeable with the 7389 and the 7389A.

RCA-7389B is a 4-1/2-inch camera tube of the image-orthicon type designed primarily to provide extremely high-quality performance in black-and-white studio TV cameras and television tape-recording operations. Because of its precision design and closely controlled characteristics, the 7389B requires only a very narrow range of camera control adjustment for optimum performance and stable day-to-day operation. The 7389B features a very high signal-to-noise ratio, excellent resolution capability, and extremely tight limits on such important performance characteristics as sensitivity, and uniformity of sensitivity and background.

The spectral response of the 7389B approaches that of the eye. It has high blue sensitivity, high green sensitivity, and negligible infrared sensitivity. The spectral sensitivity characteristic of the 7389B is shown in Fig. 1.

The superior quality of the picture signal from the 7389B permits the making of a series of successive recordings while still retaining excellent picture quality.

The "microdamp" construction features of this tube substantially decrease microphonic noise in the output signal. These features isolate the target-to-mesh assembly from the effects of external acoustical noise and camera vibration, and also rapidly damp out any internally introduced vibration of the target.

An external, black, opaque coating is applied to the lower part of the tube envelope to eliminate "washed-out" pictures due to extraneous light entering the tube.

Other features of the 7389B include a very high-capacitance target assembly which has a usable area almost 3 times greater than that of conventional 3-inch image orthicons, and a field mesh.

The high capacitance of the target assembly resulting from the increased area of the target and close target-to-mesh spacing enables the 7389B to have an extended linear portion of its light transfer characteristic and a larger output signal. The larger output signal, in turn, results in a higher signal-to-noise ratio and a longer dynamic range or gray scale. Because of the longer dynamic range, the 7389B is capable of handling a wide range of scene contrast without over exposure and undesirable secondary-electron redistribution effects.

The increased target area also greatly improves the resolution capability of the 7389B and thereby provides black-and-white TV pictures, which in addition to having greater contrast, are sharper, clearer, and more realistic. Despite the increased size of its image section, the 7389B uses the same optics and same optical-image size that are required with 3-inch tubes.

The *field mesh* reduces "white-edge" effects and geometric distortion due to beam bending and, as a consequence, a picture of better photographic quality and realism is obtained. The field mesh also improves the beam trajectory and thus eliminates dark corners in the picture area.

Contents	Page

DATA

General:

Heater, for Unipotential Cathode:

Voltage (AC or DC)	6.3 ± 10%	volts
Current at 6.3 volts	0.6	ampere

Direct Interelectrode Capacitance:

Anode to all other electrodes	12	pf
Target-to-Mesh Spacing	0.001	inch
Spectral Response		S-10
Wavelength of Maximum Response	4500 ± 300	angstroms

Photocathode, Semitransparent:

Rectangular image (4 x 3 aspect ratio):

Useful size of . . . . . . 1.6" max. Diagonal

Note: The size of the optical image focused on the photocathode should be adjusted so that its maximum diagonal does not exceed the specified value. The corresponding electron image on the target should have a size such that the corners of the rectangle just touch the target ring.[a]

Orientation of . . . Proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through the center of the faceplate and the grid-No.6 terminal. The horizontal and vertical scan should start at the corner of the picture between the grid No.6 and the photocathode terminals.

Focusing Method	Magnetic
Deflection Method	Magnetic
Overall Length	19.375" ± 0.310"
Greatest Diameter of Bulb	4.500" ± 0.094"
Envelope Terminals	5
End Base	Small-Shell Diheptal 14-Pin Base (JEDEC Group 5, No.B14-45)
Socket	Cinch[b] Part No.3M14, or equivalent

Operating Position . . . . The tube should never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with the base up makes an angle of less than 20° with the vertical.

Weight (Approx.)	2.3 lbs
Minimum Deflecting-Coil Inside Diameter	3.2"
Deflecting-Coil Length	7"
Focusing-Coil Length	15"

Alignment Coil:

Position on neck. Centerline of magnetic field should be located 9.25" from the flat area of the shoulder.

Maximum Ratings, *Absolute-Maximum Values:*[c]

PHOTOCATHODE:		
Voltage	-700 max.	volts
Illumination	50 max.	fc
OPERATING TEMPERATURE:[d]		
Any part of bulb	65 max.	°C
Of bulb at large end of tube (Image section)	35 min.	°C
TEMPERATURE DIFFERENCE:		
Between image section and any part of bulb hotter than image section	5 max.	°C
GRID-No.6 VOLTAGE	-700 max.	volts
TARGET VOLTAGE:		
Positive value	10 max.	volts
Negative value	10 max.	volts
FIELD-MESH VOLTAGE[e]	30 max.	volts
GRID-No.5 VOLTAGE	300 max.	volts
GRID-No.4 VOLTAGE	350 max.	volts
GRID-No.3 VOLTAGE	400 max.	volts
GRID-No.2 & DYNODE-No.1 VOLTAGE	350 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value	125 max.	volts
Positive bias value	0 max.	volts
VOLTAGE PER MULTIPLIER STAGE	350 max.	volts
ANODE-SUPPLY VOLTAGE[f]	1650 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	10 max.	volts

Typical Operating Values:[g]

Photocathode Voltage	-600	volts
Grid-No.6 Voltage (Image Focus) Approx. 70% of Photocathode Voltage[h]	-370 to -470	volts
Target Voltage Above Cutoff[j]	2.3	volts
Field-Mesh Voltage[e]	15 to 25	volts
Grid-No.5 Voltage (Decelerator)	40	volts
Grid-No.4 Voltage (Beam Focus)	70 to 90	volts
Grid-No.3 Voltage[k]	250 to 275	volts
Grid-No.2 & Dynode-No.1 Voltage	280	volts
Grid-No.1 Voltage for Picture Cutoff	-45 to -115	volts
Dynode-No.2 Voltage	600	volts
Dynode-No.3 Voltage	800	volts
Dynode-No.4 Voltage	1000	volts
Dynode-No.5 Voltage	1200	volts
Anode Voltage	1250	volts
Recommended Target Temperature Range	35 to 45	°C
Minimum Peak-to-Peak Blanking Voltage	5	volts
Field Strength of Focusing Coil:[m]		
At center of scanning section (Approx.)	60	gausses
In plane of photocathode (Approx.)	120	gausses
Field Strength of Alignment Coil	0 to 3	gausses

Performance Data:

With conditions shown under Typical Operating Values including Recommended Target Temperature Range; target voltage adjusted to 2.3 volts above cutoff; and with camera lens set to bring the picture highlights one-half stop above the "knee" of the light transfer characteristic

	Min.	Typical	Max.	
Cathode Radiant Sensitivity at 4500 angstroms	-	0.030	-	amp/watt
Luminous Sensitivity	30	60	-	μa/lumen
Anode Current (DC)	-	30	-	μa
Signal-Output Current (Peak to Peak)	10	-	40	μa
Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current for Bandwidth of 4.5 Mc	85:1	95:1	-	
Photocathode Illumination at 2870° K Required to bring Picture Highlights One-Half Stop above "Knee" of Light Transfer Characteristic	-	0.070	0.130	fc

Amplitude Response at 400 TV Lines per Picture Height (Per cent of large-area black to large-area white)[n]	60	75	-	%
Uniformity:[p]				
Ratio of Shading (Background) Signal to Highlight Signal	-	0.10	0.15	
Decrease from Peak Highlight Signal Level of Signal from any Point on Scanned Area of Target.	-	12	25	%

[a] If the camera employs an "orbiter", the electron image size on the target should be adjusted so that the corners of the scanned area just touch the target ring during "orbiter" operation.

[b] Made by Cinch Manufacturing Corporation, 1026 S. Homan Avenue, Chicago 24, Illinois.

[c] The maximum ratings in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[d] Operation outside of the *Recommended Target Temperature Range* shown under *Typical Operating Values* will not damage the 7389B provided the *Maximum Temperature Ratings* of the tube are not exceeded. Optimum performance, however, is only obtained when the tube is operated within the *Recommended Target Temperature Range*.

[e] With respect to grid No.4.

[f] Dynode-voltage values are shown under *Typical Operating Values*.

[g] With 7389B operated in RCA-TK-60 camera at fixed photocathode voltage.

[h] Adjust for optimum focus.

[j] The target supply voltage should be adjustable from -5 to +5 volts.

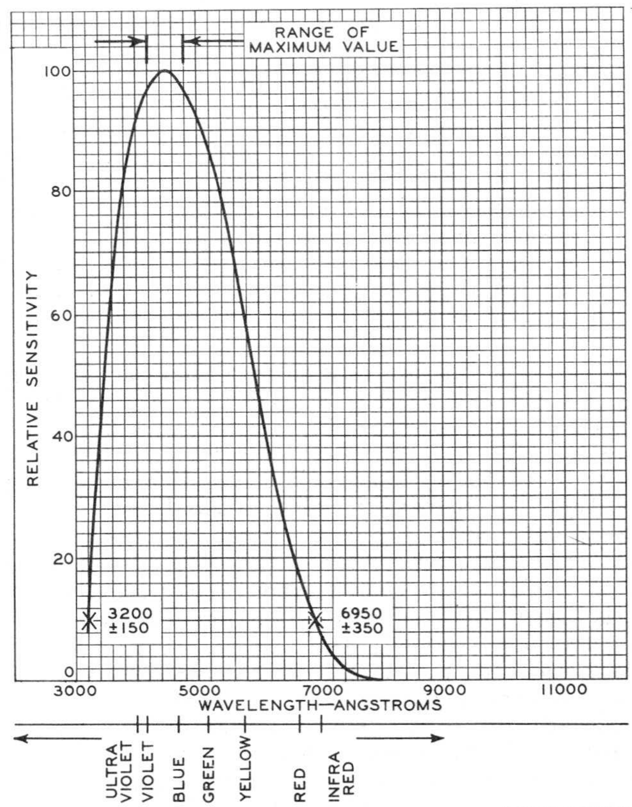
[k] Adjust to give the most uniformly shaded picture near maximum signal.

[m] Direction of current should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.

[n] Measured with amplifier having flat frequency response.

[p] With uniform illumination on photocathode.

S-10 SPECTRAL SENSITIVITY CHARACTERISTIC



92CM-7821R2

Fig.1

SET-UP PROCEDURE

The *set-up procedure* described below should be followed carefully to obtain optimum performance from the 7389B. Before the proper voltages are applied to the tube as indicated under *Typical Operating Values*, the lens should be uncapped and the lens iris opened to allow light to fall on the photocathode. *This is a very important step for this type of image orthicon.* The proper voltages should then be applied to the 7389B. Grid-No.1 voltage should immediately be adjusted to produce a small amount of beam current. This procedure will prevent the mesh from being electrostatically pulled into contact with the glass disc. Make certain that the deflection circuits are functioning properly to cause the electron beam to scan the target. Adjust the deflection circuits so that the beam will "over-scan" the target, i.e., so that the area of the target scanned is greater than its useful area. This procedure during the warm-up period is recommended to prevent burning on the target a raster smaller than that used for on-the-air operation. Note that overscanning the target results in a smaller-than-normal picture on the monitor. The lens should then be capped and the tube allowed to warm up for 15 minutes before use or before other adjustments are made.

Next, uncap the lens and partially close the lens iris. Increase the target voltage until information appears on the monitor. Then adjust beam focus, image focus, and optical focus until detail can be discerned in the picture. Adjust the alignment-coil-current controls until picture response is maximum. If the picture appears in negative contrast, increase the beam current. Further adjust the alignment-coil current so that the center of the picture does not move when the beam-focus control (grid No.4) is varied, but simply goes in and out of focus. Auto-alignment devices are useful for determining the exact setting of alignment coil current. During alignment of the beam, and also during operation of the tube, always keep the beam current as low as possible to give the best picture quality and also to prevent excessive noise.

Next, focus the camera on a test pattern. The target voltage is then advanced or reduced to the point where a reproduction of the test pattern is just discernible on the monitor. This value of target voltage is known as the "target-cutoff voltage". The target voltage should then be increased to between two and three volts above cutoff, and the beam-current control adjusted to give just sufficient beam current to discharge the highlights. If two or more cameras are to be used concurrently in the studio, it is important that each camera use the same value of target voltage so that the reproduced pictures are easily matched. It is to be noted that the use of high target voltage produces a higher signal-to-noise ratio and better contrast than the signal-to-noise ratio and contrast produced using low target voltages. However, high target voltages tend to reduce tube life, introduce microphonic noise and flicker, and generally reduce picture sharpness.

The lens is then adjusted to produce best optical focus, and the voltages on grid No.6 and grid No.4 are adjusted to produce the sharpest picture.

If the 7389B is used in cameras other than RCA TK-60, the range of grid-No.4 voltage should be varied to obtain that focus mode which yields the "flattest" picture, produces the least interference from mesh in the background at low lights, eliminates dark corners, and gives the best center-to-edge focus.

In cameras where both grid-No.6 and the photocathode voltages are variable, the photocathode voltage should be adjusted to produce the best focus with grid No.6 set at approximately 70% of the photocathode voltage. This value of grid-No.6 voltage should minimize picture distortion and produce best center-to-edge focus.

At this point, attention should be given to the grid-No.5 control. If grid-No.5 voltage is adjustable, it should be varied to produce the best center-to-edge focus and the best picture geometry. When changing grid-No.5 voltage, it will be necessary to refocus the scanning section by adjusting grid-No.4 voltage control.

After the above-mentioned controls are properly set, the grid-No.3 control should be adjusted for maximum signal output. The deflecting yoke and 7389B should be rotated, if necessary, so that the horizontal scanning of the camera is parallel to the horizontal plane of the scene.

The above adjustments constitute a rough set-up for the 7389B. Final adjustments necessary for the 7389B to produce the best possible picture are as follows:

The proper illumination level should first be determined. Adjust the target voltage to the desired point above the target-cutoff value. Focus the camera on a neutral (black-and-white) test pattern consisting of progressive tonal steps from black to white. Open the lens iris just to the point where the highest step of the test pattern does not rise as fast as the lower steps when viewed on a video-waveform oscilloscope. Then open the camera lens approximately 1/2 stop above this setting. This operating point assures the maximum signal, best gray scale, freedom from "black borders", and the sharpest picture.

Then adjust the grid-No.1 voltage control to just discharge the brightest highlight of the pattern.

Next, adjust the grid-No.3 voltage control so that the video signal has a maximum value consistent with a flat-background signal when the lens is capped. This background represents the black level of the picture.

The video-gain control is adjusted to produce the maximum output signal without overloading the camera amplifier. The proper operating levels are usually specified by the camera manufacturer.

From this point on, the waveform monitor for the camera should be used to determine the lens opening necessary to produce the maximum desired highlight signal as determined with the neutral step pattern, and no changes should be made on the video-amplifier or image-orthicon multiplier-gain controls.

If a wider range of tonal values is desired, black-stretch circuitry or gamma-correction circuitry should be used instead of opening the lens further. The high value of signal-to-noise ratio produced by the 7389B permits the use of gamma-correction circuitry to achieve a good range of tonal values in the picture without encountering excessive noise. In addition, operation with this correction will prolong the life of the tube by reducing the amount of current drawn through the target glass.

OPERATING CONSIDERATIONS

Support for the 7389B should be designed so that vibration and shock will not cause the tube to be displaced with respect to the focusing, deflecting, and alignment fields.

Proper orientation of the envelope terminal socket with respect to the deflecting field is essential, and is obtained when the plane that passes through the key on the diheptal base, the grid-No.6 terminal on the tube envelope, and the tube axis is parallel to the vertical deflection field. This orientation minimizes beat-pattern effects by placing the sides of the mesh holes at an angle of 45° with respect to the horizontal scanning lines.

The deflecting yoke and focusing coil used with the 7389B incorporate means to prevent the magnetic field produced by the deflecting yoke from extending into the image section of the tube. Unless proper shielding is provided, cross-talk from the deflecting yoke into the image section will cause the electron image to "jitter". This jitter produces a loss of picture sharpness.

A blanking signal should be supplied to the target to prevent the electron beam from striking the target during the return portions of the horizontal and vertical deflecting cycles. Unless this is done, the camera-tube return lines will appear in the received picture.

The blanking signal is a series of negative voltage pulses. The voltage between pulses must be constant to prevent fluctuation of the target voltage. During the blanking period, the full beam current without video-signal modulation is returned to the multiplier and its multiplied output flows through the load resistance. Excessive amounts of blanking voltage applied to the target will impair resolution, because during retrace the emitted photoelectrons are no longer in focus with the target. A desirable amount of target blanking is 6 volts peak to peak.

Shading may be required even with optimum adjustment of voltage on grid No.3 in order to obtain a more uniformly shaded picture. A sawtooth waveform of adjustable amplitude and polarity at both the vertical- and horizontal-scanning frequency should be provided for insertion in the video amplifier to aid in obtaining a flat background.

Failure of scanning even for a few seconds may permanently damage the surface of the target. The damaged area shows up as a spot or line in the picture during subsequent operation.

The *operating temperature* of any part of the glass bulb should never exceed 65° C, and no part of the bulb at the large end of the tube (image section) should ever fall below 35° C during operation. For best results, it is recommended that the temperature of the entire bulb be held between 35° and 45° C. Operation at too low a temperature will be characterized by the appearance of a rapidly disappearing "sticking picture" of opposite polarity from the original when the picture is moved. Operation at too high a temperature is not only characterized by an increase in microphonic noise but will also cause loss of resolution and possibly permanent damage to the tube. The loss of resolution is caused by the decreasing resistivity of the target glass disc with increasing temperature. As a result, lateral leakage of the image charge occurs. Tube temperature should always be checked if a loss in resolution occurs during tube operation. Resolution is regained by waiting for the temperature to drop. *No part of the bulb should run more than 5° C hotter than the image section to prevent cesium migration to the target.* Such migration will result in loss of resolution and in probable permanent damage to the tube. Like other photosensitive devices employing cesium, the 7389B may show fluctuations in performance from time to time. Strict observance of the above recommendations with respect to operating temperature will not completely eliminate these variations but will greatly improve stability of the characteristics during the life of the tube.

When the operating conditions are such that the maximum temperature rating or maximum temperature difference as given under *Maximum Ratings* will be exceeded, provision should be made to direct a blast of cooling air from the diheptal-base end of the tube along the entire length of the bulb surface, i.e., through the space between the bulb surface and the surrounding deflecting-coil assembly and its extension.

To keep the operating temperature of the large end of the tube from falling below 35° C, some form of controlled heating should be employed. Ordinarily, adequate heat will be supplied by the focusing coil, deflecting coils, and associated amplifier tubes so that the temperature can be controlled by the amount of cooling air directed along the bulb surface.

A *mask* having a diagonal or diameter of 1.6 inches should always be used on the photocathode to reduce the amount of light reaching unused parts of the photocathode.

The *optical system* used with the 7389B should be of high quality and should incorporate control of the amount of light entering the television camera lens. This control may consist of an iris or an iris and suitable neutral-density filters. The entire optical system should have all inside surfaces finished in mat black to prevent internal reflections from reaching the photocathode. Under almost all conditions, the use of a lens shade is beneficial.

OPERATING INSTRUCTIONS

The 7389B is designed to have stable operating characteristics which ensure optimum performance from day-to-day with minimum camera control adjustment.

Installation of the 7389B in the camera is accomplished by inserting the diheptal-base end of the tube through the coil assembly and then inserting the tube in the envelope terminal socket. Proper insertion aligns the white radial line on the face with the bottom terminal socket for grid No.6. The 7389B has two complementary guides for inserting the tube correctly, the grouping of the envelope terminals and a white radial line on the face of the envelope.

The *operating position* of the 7389B should preferably be such that any loose particles in the neck of the tube will not fall down and strike or become lodged on the target. Therefore, it is recommended that the tube never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with base up makes an angle of less than 20° with the vertical.

Full-size scanning of the target should always be used during operation to assure maximum signal-to-noise ratio and maximum resolution. Note that overscanning the target produces a smaller-than-normal picture on the monitor.

Underscanning the target, i.e., scanning an area of the target less than the desired area, should never be permitted. Underscanning produces a larger-than-normal picture on the monitor. If the target is underscanned for any length of time, a permanent change in target-cutoff voltage of the underscanned area takes place with the result that the underscanned area thenceforth is visible in the picture when full-size scanning is restored.

Retention of a scene by the 7389B, sometimes called a "sticking picture", may be observed if the 7389B is allowed to remain focused on a stationary bright scene, or if it is focused on a bright scene before reaching operating temperature in the range from 35° to 45° C. Often the retained image will disappear in a few seconds, but sometimes it may persist for long periods before it completely disappears. A persisting retained image can generally be removed by focusing the 7389B on a clear white screen and allowing it to operate with an illumination of about 1 foot-candle on the photocathode until the retained image disappears.

To minimize retention of a scene, it is recommended that the 7389B always be allowed to warm up in the camera for 1/4 hour with the lens capped. Never allow the 7389B to remain focused on a stationary bright scene, and never use more illumination than is necessary.

Occasionally, a *white spot* which does not change in size when the beam-focus voltage is varied, may be observed in the center of the picture. Such a spot, especially if it is visible on the monitor with the camera lens capped, is probably an ion spot. If the spot begins to grow in size with continuous operation, the 7389B should be removed from service at once, and returned for re-processing. Continued operation of an image orthicon with an ion spot will eventually damage the target permanently.

Video Gain is controlled over a wide range by reducing the voltage on one or more of the multiplier dynodes. Provision to vary the voltage on dynode No.3 is generally provided in the camera as the *Video Gain Control*. Dynode No.2 should be maintained at a fixed voltage for best signal-to-noise ratio and shading. Because individual 7389B's may have a dc output range of 10 to 1, such a gain control is required to prevent possible overload of the video amplifier when a 7389B having a high signal output or high current amplification is used. However, this control should not be adjusted to reduce the output signal of the 7389B to such a low value that noise in the video amplifier stages is contributed to the final video signal.

During standby operation, the lens of the camera should always be closed or capped. An effective method of performing the same end result is to cut off the photocathode voltage by means of a switch. The camera will instantly be ready for operation when the photocathode voltage is again turned on.

PERFORMANCE CHARACTERISTICS

The *light transfer characteristic* of the 7389B changes for different illumination levels (see Reference 3). The basic light transfer characteristic of the 7389B is shown in Fig. 2. The light

BASIC LIGHT TRANSFER CHARACTERISTIC

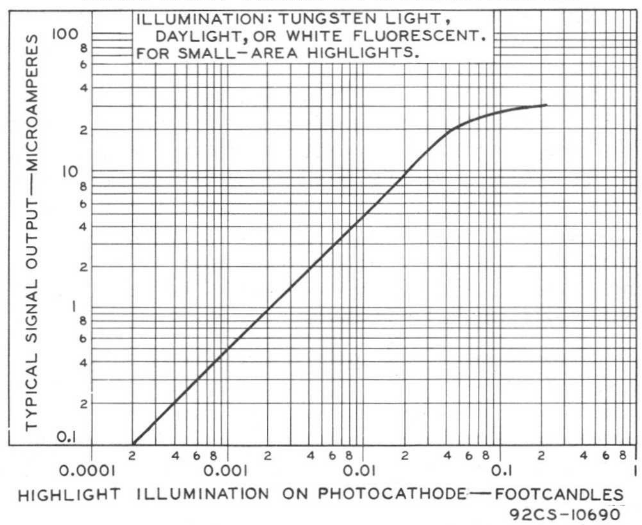


Fig.2

values shown are applicable only for the indicated kinds of illumination incident on the photocathode. This curve is representative only for small-area highlights.

Sensitivity and Illumination. The image orthicon is a device exceeding in relative sensitivity most high-speed photographic film. When related to photographic film and compared at shutter speeds of 1/60 second which is the effective storage time of the image orthicon in a standard broadcast television system, the 7389B exposed with the highlights on the photocathode of 0.075 footcandle will have an equivalent ASA exposure index of approximately 2000. This equivalent film-speed rating can be used in conjunction with a photographic exposure meter set for a shutter speed of 1/60 second to determine the approximate light level or lens-stop setting necessary for operating the 7389B in a standard broadcast system.

The illumination on the photocathode of the 7389B is related to the scene illumination as follows:

$$I_s = \frac{4f^2 \ I_{pc} \ (m + 1)^2}{TR}$$

where:

I_s = scene illumination in footcandles
f = f-number setting of lens
I_{pc} = photocathode illumination in footcandles
m = linear magnification from scene to photocathode
T = total transmission of lens
R = reflectance of principal subject in scene

Except for very close shots, the linear magnification (m) from scene to photocathode may be neglected.

For example, assume that the lens is set at f:8, that it has a transmission (T) of 75%, that the required photocathode highlight illumination is 0.075 footcandle, and that the highlight reflectance (R) is 50%.
Then,

$$I_s = \frac{4 \times 8^2 \times 0.075}{0.75 \times 0.50} = 51 \text{ footcandles}$$

Optimum resolution and best performance is obtained when the 7389B is operated with the lens set no more than 1/2 lens stop above the knee of the light transfer characteristic. Under certain lighting conditions, such as direct sunlight, it may not be possible to stop the lens down far enough to obtain this level of highlight illumination on the photocathode. When such a condition is encountered, the use of a neutral-density filter selected to give the required reduction in illumination is recommended.

The low illumination level utilized on the photocathode of the 7389B makes it necessary that no stray light from without or within the camera fall on the face of the tube. See *optical system* under *Operating Considerations*.

PRINCIPLES OF OPERATION

The 7389B has three sections--an image section, a scanning section, and a multiplier section--as shown in Fig. 3.

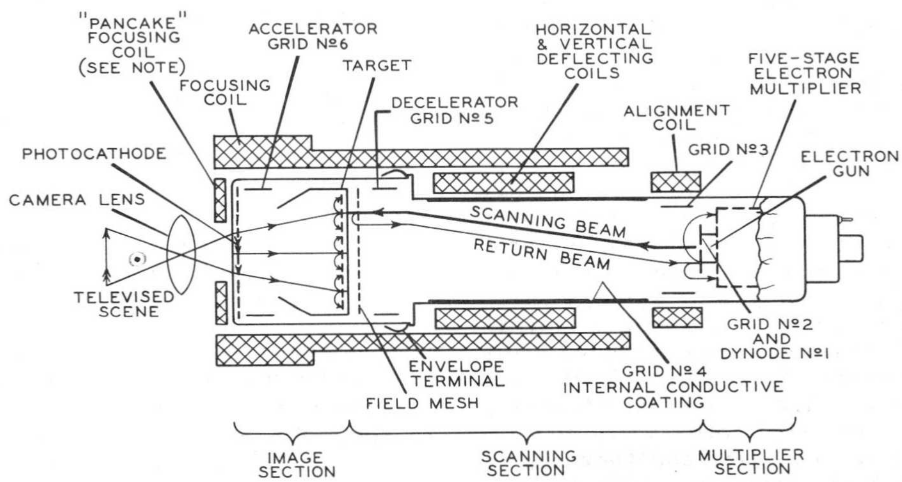
Image Section

The image section contains a semitransparent photocathode, on the inside of the faceplate, a grid (grid No.6) which together with the photocathode provides an electrostatic accelerating field, and a target which consists of a very thin glass disc with a fine micro-mesh screen very closely spaced to it on the photocathode side. Focusing is accomplished by means of a non-uniform graded magnetic field produced by an external coil, and by the electrostatic accelerating field produced between the photocathode and grid No.6. Control of the electrostatic field shape for best focus is effected by the proper selection of photocathode voltage and adjustment of grid-No.6 voltage.

Light from the scene being televised is picked up by an optical system and focused on the photocathode which emits electrons from each illuminated area in proportion to the intensity of the light striking the area. The streams of electrons are focused on the target by the magnetic and electrostatic accelerating fields. The shape of the graded-magnetic field is such that the optically-focused photocathode image is electro-optically magnified between the photocathode and the target.

On striking the target, the electrons cause secondary electrons to be emitted by the glass. The secondaries thus emitted are collected by the adjacent mesh screen which is held at a definite small positive potential with respect to target-cutoff voltage. Therefore, the potential of the glass disc is limited for all values of light and stable operation is achieved. Emission of the secondaries leaves on the photocathode side of the glass a pattern of positive charges which corresponds with the pattern of light from the

SCHEMATIC ARRANGEMENT AND ASSOCIATED COMPONENTS



NOTE: "PANCAKE" FOCUSING COIL IS CONNECTED IN SERIES AIDING WITH MAIN FOCUSING COIL.

Fig.3

scene being televised. Because of the thinness of the glass, the charges set up a similar potential pattern on the opposite or scanned side of the glass.

Scanning Section

The opposite side of the glass is scanned by a low-velocity electron beam produced by the electron gun in the scanning section. This gun contains a thermionic cathode, a control grid (grid No.1), and an accelerating grid (grid No.2). The beam is focused at the target by the magnetic field of an external focusing coil and the electrostatic field of grid No.4.

Deflection of the beam is accomplished by transverse magnetic fields produced by external deflecting coils.

Alignment of the beam from the gun is accomplished by a transverse magnetic field produced by external coils located at the gun end of the focusing coil.

By proper adjustment of potentials including that of grid No.5 and the field mesh, the beam is caused to approach the target perpendicularly and with zero or nearly zero velocity. Electrons which approach uncharged portions of the pattern on the glass stop their forward motion at the surface of the glass and are turned back and focused into a five-stage multiplier. Beam electrons that approach positively charged portions of the pattern on the glass are deposited from the scanning beam in quantities sufficient to neutralize the potential pattern on the glass before the beam is turned back and focused into the signal multiplier. Such deposition leaves the glass with a negative charge on the scanned side and a positive charge on the photocathode side. These charges neutralize each other by conductivity through the glass in less than the time of one frame.

The electrons turned back at the target form the return beam which has been amplitude modulated by absorption of electrons at the target in accord with the charge pattern whose more positive areas correspond to the highlights of the televised scene.

The field mesh--a fine-mesh screen of high electron transmission--acts to increase the strength of the decelerating field immediately in front of the target. The field mesh also defocuses the return beam so that the texture of the first dynode does not appear in the background of the picture. The uniform gradient of the decelerating field over the scanned area causes the beam to approach the target perpendicularly at all points on the target. The enhanced field also prevents the charge pattern on the target from bending the beam away from its proper trajectory. The over-all result of these two effects is to enable the 7389B to produce a picture that is relatively free of unwanted bright edges or overshoots at the boundary of brightly illuminated portions of a scene. The strong decelerating field also allows the 7389B to be operated with high values of target voltage, and thereby, to produce extremely high signal-to-noise ratios.

Multiplier Section

The return beam is directed to the first dynode of a five-stage electrostatically focused multiplier. This utilizes the phenomenon of secondary emission to amplify the modulated beam current more than 500 times. The electrons in the beam impinging on the first-dynode surface produce many other electrons. These secondary electrons are then directed to the second dynode and knock out more new electrons. Grid No.3 facilitates a more complete collection by dynode No.2 of the secondaries from dynode No.1. The multiplying process is repeated in each successive stage, with an ever-increasing stream of electrons until those emitted from dynode No.5 are collected by the anode and constitute the current utilized in the output circuit.

The signal-to-noise ratio of the output signal from the 7389B is very high. The gain of the multiplier is such as to raise the output signal sufficiently above the noise level of the video amplifier stages so that they contribute no noise to the final video signal. The signal-to-noise ratio of the video signal, therefore, is determined primarily by random variation in the quantity of the electrons in the modulated electron beam.

As the beam moves from a less-positive portion of the target to a more-positive portion, the signal-output voltage across the load resistor changes in the positive direction. Hence, for highlights in the scene, the grid of the first video amplifier stage swings in the positive direction.

REFERENCES

1. D.G. Fink, Television Engineering Handbook, McGraw-Hill Co., New York, 1957.
2. Otto H. Schade, *"Electro-Optical Characteristics of Television Systems"*; Introduction and Part II - *"Electro-Optical Specifications for Television Systems"*, RCA Review, June, 1948: Part III - *"Electro-Optical Characteristics of Camera Systems"*, RCA Review, September, 1948.
3. R.B. Janes, and A.A. Rotow, *"Light Transfer Characteristics of Image Orthicons"*, RCA Review, September, 1950.
4. A.A. Rotow, *"Reduction of Spurious Signals in Image Orthicon Cameras"*, Broadcast News, February, 1955.
5. E.D. Hendry, and W.E. Turk, *"An Improved Image Orthicon"*, Journal of the Society of Motion Picture and Television Engineers, February, 1960.
6. R. Theile, *"Recent Investigations into the Operation of Image Orthicon Camera Tubes"*, Journal of the Television Society, June, 1959.
7. R.G. Neuhauser, *"Characteristics and Mode of Operation of Image Orthicons"*, Proceedings of the Convention of The National Association of Broadcasters, April, 1962.
8. D.C. Brothers, *"Contrast Law Correction in Television Picture Generators"*, Journal of Television Society, Dec., 1960.

DOS and DON'TS
on Use of RCA-7389B

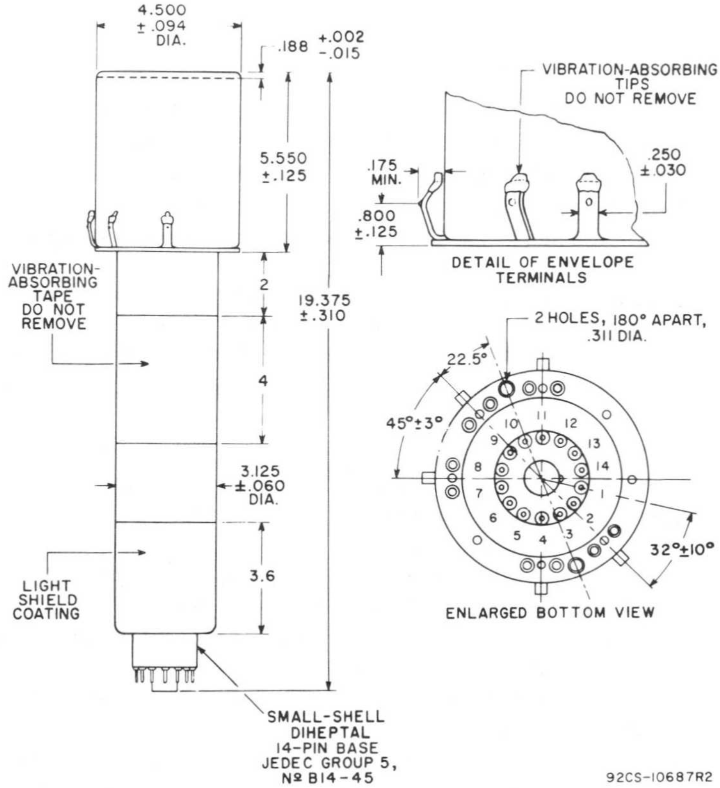
Here are the "dos"—

1. Allow the 7389B to warm up prior to operation.
2. Hold temperature of the 7389B within operating range.
3. Make sure alignment coil is properly aligned.
4. Adjust beam-focus control for best usable resolution.
5. Condition spare 7389B's by operating several hours once each month.
6. Determine proper operating point with target voltage adjusted to the desired voltage above target-cutoff.
7. Open lens before voltages are applied to the 7389B.

Here are the "don'ts"—

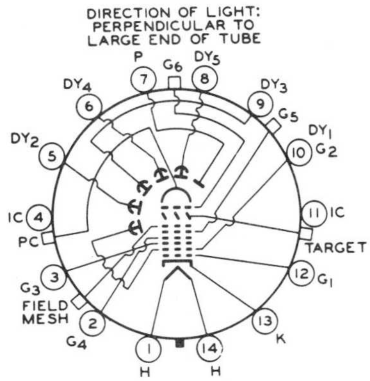
1. Don't force the 7389B into its envelope terminal socket.
2. Don't operate the 7389B without scanning.
3. Don't underscan target.
4. Don't focus the 7389B on a stationary bright scene.
5. Don't operate a 7389B having an ion spot.
6. Don't use more beam current than necessary to discharge the highlights of the scene.
7. Don't operate 7389B with target voltage greater than 3 volts above cutoff.
8. Don't turn off beam while voltages are applied to photocathode, grid No.6, target, dynodes, and anode during warm up or standby operation.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

BASING DIAGRAM
Bottom View



SMALL-SHELL DIHEPTAL 14-PIN BASE

Pin 1 – Heater
Pin 2 – Grid No.4
Pin 3 – Grid No.3
Pin 4 – Internal Connection—Do Not Use
Pin 5 – Dynode No.2
Pin 6 – Dynode No.4
Pin 7 – Anode
Pin 8 – Dynode No.5
Pin 9 – Dynode No.3
Pin 10 – Dynode No.1 Grid No.2
Pin 11 – Internal Connection—Do Not Use
Pin 12 – Grid No.1
Pin 13 – Cathode
Pin 14 – Heater

ENVELOPE TERMINALS

Terminal Over Pin 2 – Field Mesh
Terminal Over Pin 4 – Photocathode
Terminal On Side Of Envelope Opposite Base Key – Grid No.6
Terminal Over Pin 9 – Grid No.5
Terminal Over Pin 11 – Target

RCA

This bulletin is to be used in conjunction with the bulletin for the RCA-7389B.

RCA-7389B/L
IMAGE ORTHICON

Magnetic Focus
Magnetic Deflection
4.500" Diameter
19.375" Length

Long-Life Target, Field-Mesh Type for High-Quality Black-and-White TV Cameras.

The 7389B/L is directly interchangeable with the 7389, 7389A, and 7389B in all cameras.

RCA-7389B/L is a 4-1/2-inch image orthicon type camera tube designed primarily to provide extremely high-quality performance in black-and-white studio TV cameras and television tape-recording operations. The 7389B/L features a very high signal-to-noise ratio, excellent resolution capability, and extremely tight limits on such important performance characteristics as sensitivity, and uniformity of sensitivity and background. It employs a stable, long-life glass target that is characterized by high gain, resistance to "burn-in", and the absence of any granular structure. The electrical characteristics of the target, such as secondary emission and resistivity, are essentially constant and sensitivity of the 7389B/L is stable throughout life because the conduction mechanism involved with transfer of charge through this target material is electronic rather than ionic as in ordinary glass targets.

Other important advantages of this target are that the undesirable characteristics of scene retention or "sticking picture" and raster "burn-in" due to underscanning are significantly reduced. The resistance of the 7389B/L to image "burn-in" provides a highly desirable operational feature because it is not necessary to use an orbiter or continually move the camera when focused on a stationary scene.

The paragraphs in the attached 7389B/L bulletin discussing *Underscanning the target* and *Retention of a scene* on page 6 do not apply to the 7389B/L.

Features of the 7389B/L include:

- Stable, Long-Life Target
- Constant Target Gain
- Minimal "Sticking Picture" and Raster "Burn-in" Problems
- Stable Sensitivity throughout Useful Tube Life
- Microdamp Construction

DOS and DON'TS on Use of RCA-7389B/L

Here are the "dos"

1. Allow the 7389B/L to warm up prior to operation.
2. Hold temperature of the 7389B/L within operating range.
3. Make sure alignment coil is properly adjusted.
4. Adjust beam-focus control for best usable resolution.
5. Condition spare 7389B/L's by operating several hours once each month.
6. Determine proper operating point with target voltage adjusted to the desired voltage above target-cutoff.
7. Uncap lens before voltages are applied to the 7389B/L.

Here are the "don'ts"

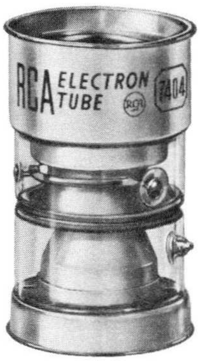
1. Don't force the 7389B/L into its shoulder socket.
2. Don't operate the 7389B/L without scanning.
3. Don't operate a 7389B/L having an ion spot.
4. Don't use more beam current than necessary to discharge the highlights of the scene.
5. Don't turn off beam while voltages are applied to photocathode, grid No.6, target, dynodes, and anode during warm-up or standby operation.

RCA-7404

IMAGE-CONVERTER TUBE

Electrostatic Focus	Monovoltage Type	2.33" Max. Length
High Resolution	S-21 Response	0.75" Max. Radius

RCA-7404 is a self-focusing image-converter tube useful in combination with suitable optical systems for viewing an object or specimen irradiated with near-ultraviolet radiation. It utilizes a semitransparent photocathode at one end on which the object to be viewed is focused by means of an optical objective. Electrons from the image on the photocathode are electrostatically focused on the fluorescent screen at the other end of the tube by electron-optical methods to form a reduced image which can be viewed with an optical magnifier. The inverted image produced by the optical system on the photocathode is reinverted by the 7404 to give an observed image that is erect.



The 7404 is a monovoltage type, i.e., it operates with only a single voltage applied between its two terminals, and remains in focus with any applied voltage in the operating range from 8000 to 12000 volts. The voltage may be obtained from an unregulated rectified-power supply without a bleeder. Filtering can be provided by a single capacitor. Its value should be such as to provide a high ratio of average dc voltage to ripple voltage in order to obtain the highest average voltage, and hence the highest screen brightness, without exceeding the maximum voltage rating of the tube. Under typical viewing conditions, the value of operating power is less than 10 milliwatts at 12000 volts.

Features of the 7404 include a photocathode faceplate of ultraviolet-transmitting glass, a spectral response covering the range from about 2350 to 6200 angstroms with peak at about 4400 angstroms, high ratio of light output to ultraviolet-energy input at 2537 angstroms, minimum resolution of 50 line-pairs per millimeter, and low-pin-cushion distortion. These features, together with those of small size, low power requirements, and self-focusing over a wide range of operating voltage, make the 7404 especially suitable for use in ultraviolet microscopy.

DATA

General:

Spectral Response	S-21
Wavelength of Maximum Response	4400 ± 500 angstroms
Photocathode, Semitransparent:	
Shape	Convexo-Concave ←
Minimum useful diameter	0.75"
Fluorescent Screen:	
Shape	Plano-Plano ←
Minimum useful diameter	0.57"
Phosphor	P20, Aluminized
Fluorescence	Yellow-Green
Phosphorescence	Yellow-Green
Persistence	Medium-Short
Focusing Method (Self-focusing)	Electrostatic
Overall Length	2.28" ± 0.05"
Greatest Diameter (Excluding side tip)	1.35" ± 0.03"
Maximum Radius (Including side tip)	0.75"
Terminals	See *Dimensional Outline*
Operating Position	Any
Weight (Approx.)	1.5 oz

Maximum Ratings, *Absolute-Maximum Values:*[a]

FLUORESCENT-SCREEN VOLTAGE:[b]		
Average (DC)	12500 max.	volts
Peak Instantaneous	13000 max.	volts
AVERAGE PHOTOCATHODE CURRENT (Continuous Operation)[c]	0.35 max.	μA
AMBIENT TEMPERATURE	75 max.	°C

Characteristics at Ambient Temperature of 22°C:

Fluorescent-Screen Voltage (DC)[b]	12000	volts
Typical Paraxial Magnification Factor[d]	0.735	
Typical Conversion Efficiency[e]	6000	lumens/watt
Minimum Resolution[f]	50	line-pairs per mm ←
Typical Equivalent Screen-Background Input at 2537 angstroms[g]	1×10^{-10}	watt/cm^2

[a] The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices. Absolute-maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in device characteristics.

← Indicates a change.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

b Referred to photocathode.

c Averaged over any interval of 10 seconds maximum.

➞ d Defined as the ratio of the linear size of the image on the fluorescent screen to the linear size of the image on the photocathode. The image on the photocathode consists of two parallel lines 0.08" long, each located 0.075" from the tube axis. Size of the image on the fluorescent screen is determined by measuring the spacing between the two parallel lines.

e Defined as the quotient of luminous flux output to incident radiant flux at 2537 angstroms.

f The resolution, both horizontally and vertically in a 0.15-inch-diameter circle centered on the photocathode, is determined with a pattern consisting of alternate black and white lines of equal width. Any two adjacent lines are designated as a "line-pair".

g Defined as that value of incident radiation required to cause an increase in screen brightness equal to the screen background brightness.

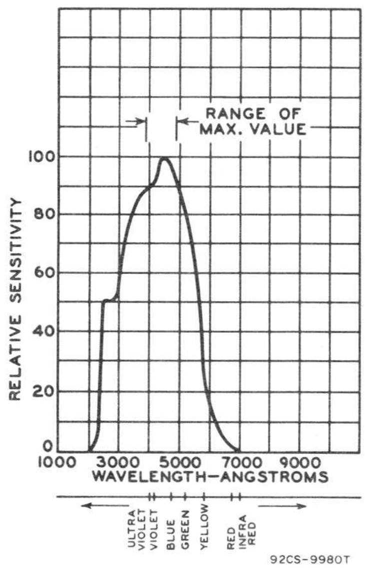


Fig.1 - Spectral Sensitivity Characteristic of Type 7404 which has S-21 Response. Curve is shown for Equal Values of Radiant Power at All Wavelengths.

OPERATING CONSIDERATIONS

The *maximum ambient temperature* shown in the tabulated data is a tube rating which is to be observed in the same manner as other ratings. This rating should not be exceeded because too high a face temperature may cause the volatile photocathode surface to evaporate with consequent decrease in life and sensitivity of the tube.

Handling. The 7404 should be handled by the metal terminals. Fingerprints on the glass should be avoided since they cause leakage current, corona, and higher screen background. To minimize the possibility of leakage current and corona, the external surface of the glass side wall is coated with a transparent, non-hygroscopic film. This film should be cleaned only with a soft dry cloth.

The *spectral response* of the 7404 is shown by the curve of Fig.1.

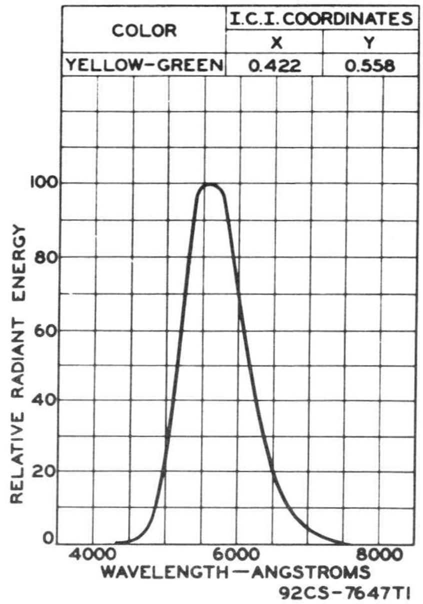


Fig.2 - Spectral-Energy Emission Characteristic of Phosphor P20.

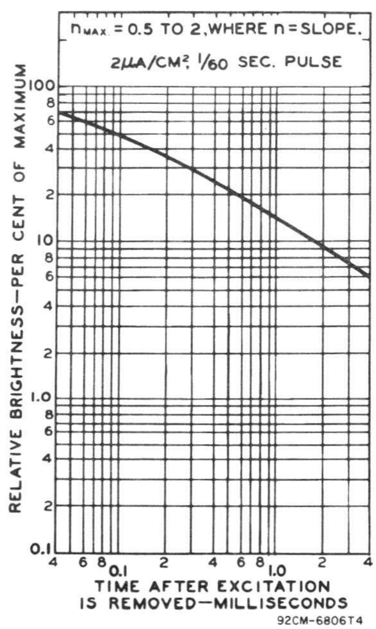


Fig.3 - Persistence Characteristic of Phosphor P20.

➞Indicates a change.

The *fluorescent screen* employs the fine-grain phosphor P20 which fluoresces to produce a yellow-green luminescence. It has good visual qualities as well as high luminous efficiency. The spectral-energy emission characteristic of phosphor P20 is shown in Fig.2 and its persistence characteristic in Fig.3.

The *light output* from the 7404 as a function of fluorescent-screen voltage is given in Fig.4.

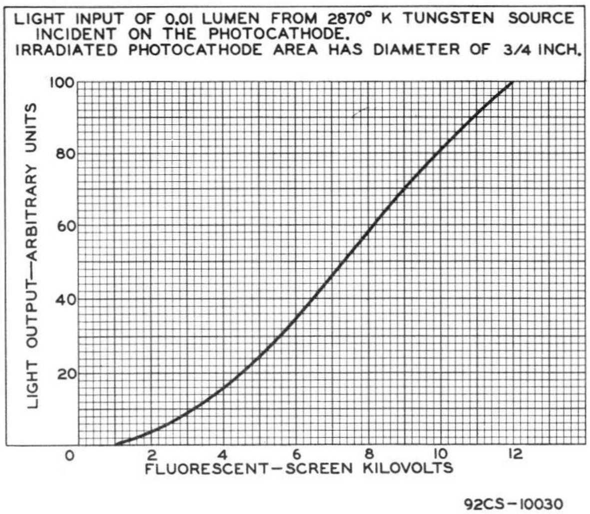


Fig.4 - Typical Characteristic of Type 7404.

The effect on *magnification, pincushion distortion,* and *resolution* as the distance is increased from the center of the photocathode toward its edge, is shown by the curves in Fig.5.

Subjecting the 7404 to intense incident-radiation levels may temporarily decrease the tube's sensitivity even though there is no voltage applied. The magnitude and duration of this decrease depend on the length of exposure. Permanent damage to the tube may result if it is exposed to radiant energy so great as to cause excessive heating of the photocathode.

Connections to the two terminals of the tube, indicated on the *Dimensional Outline,* should not be soldered to the terminals. They may be made by spring fingers engaging the rim or the straight side of each terminal.

Magnetic shielding of the 7404 is required to minimize the effects of extraneous fields on tube performance. It is to be noted that ac magnetic fields are particularly objectionable in that they seriously impair tube resolution. If an iron or steel case is used, care should be taken in its construction to insure that the case is completely demagnetized.

A mounting-arrangement guide is shown in Fig.6. It is intended to point out some of the areas that must be considered when designing a mounting arrangement. For example, to avoid corona effects, the metal parts on the end of the tube that are not at ground potential must be free of sharp edges. The tube is normally operated with the anode end at ground potential. However, either end of the tube may be grounded. The photocathode potential extends from the photocathode flange to the slight indentation in the tube envelope. Any mounting fixture at anode potential must, therefore, be insulated from this area of the bulb. The pressure holding the tube in compression may be as high as 40 pounds. However, only the minimum amount of uniformly distributed pressure necessary to hold the tube firmly in position for a given application should be employed.

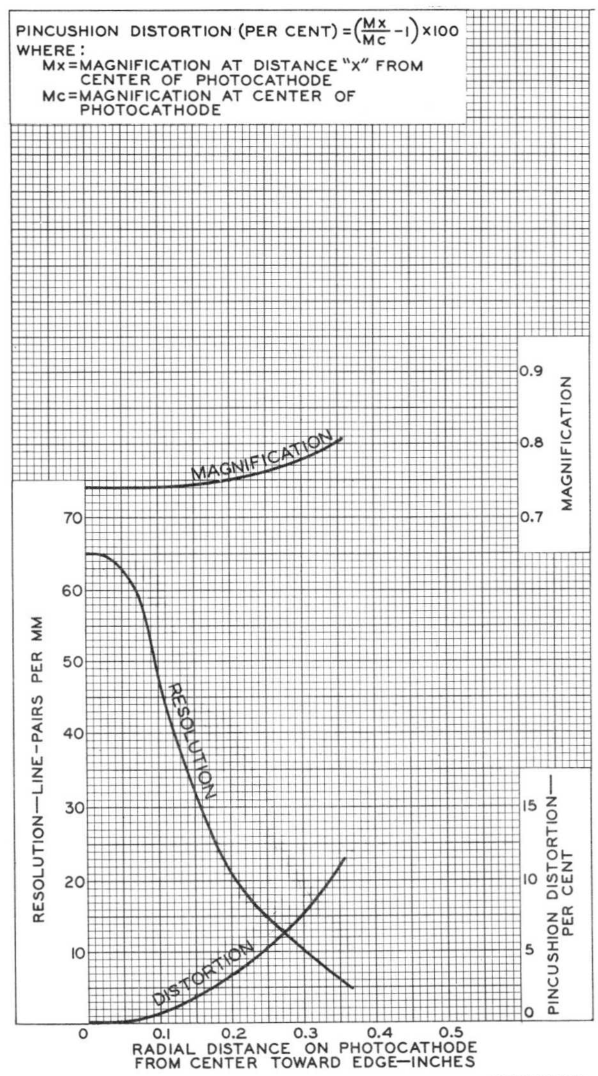


Fig.5 - Typical Characteristics of Type 7404.

The *dc supply voltage* for the 7404 may be obtained from a high-voltage power-supply unit. Units are offered commercially by several manufacturers listed in buyers' guides.

The *high voltage at which the 7404 is operated may be very dangerous.* Great care should be taken in the design of apparatus to prevent the user from coming in contact with the high voltage. Precautions must include safeguards which eliminate all hazards to operating personnel. In the use of high-voltage tubes, such as the 7404, it should always be remembered that high voltage may appear at normally low-potential points in the circuit because of capacitor breakdown or incorrect circuit connections. Before any part of the circuit is touched, the voltage-supply switch should be turned off and both terminals of any capacitors grounded.

MOUNTING ARRANGEMENT GUIDE

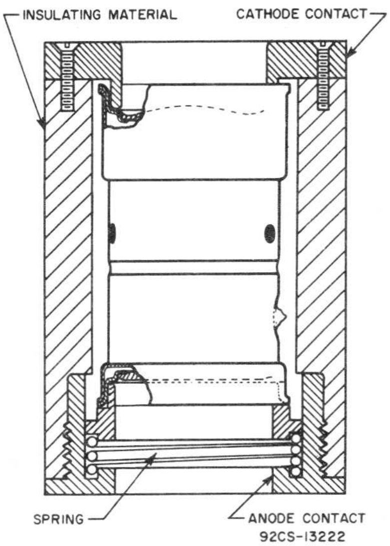
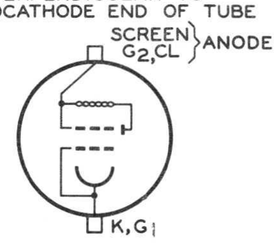


Fig. 6

TERMINAL CONNECTIONS

(See Dimensional Outline)

DIRECTION OF INCIDENT RADIATION: PERPENDICULAR TO PHOTOCATHODE END OF TUBE



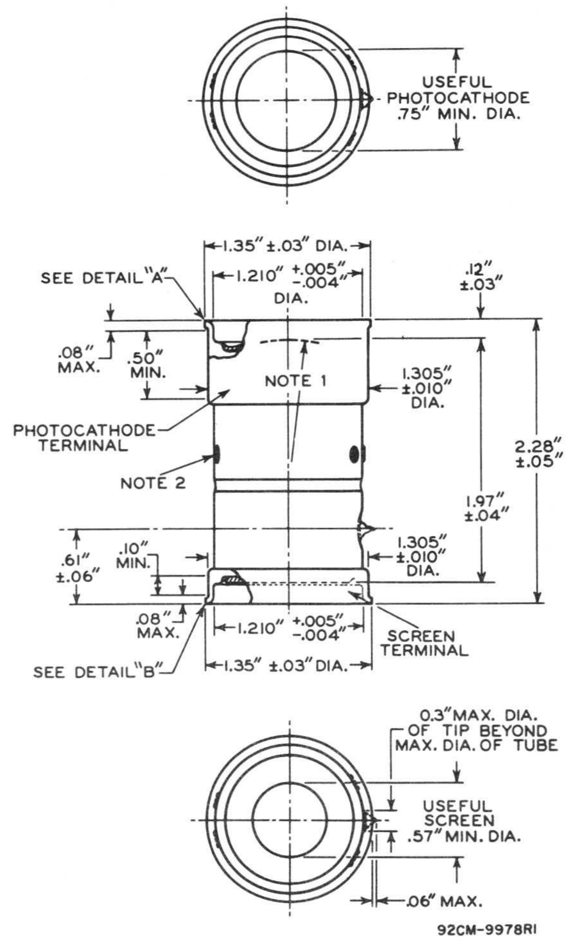
CL: COLLECTOR

G_1: GRID No.1 (FOCUSING ELECTRODE)

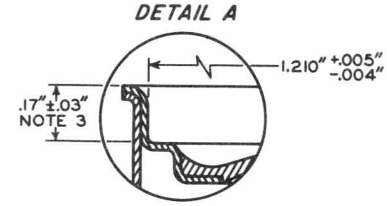
G_2: GRID No.2 (FOCUSING & ACCELERATING ELECTRODE)

K: PHOTOCATHODE

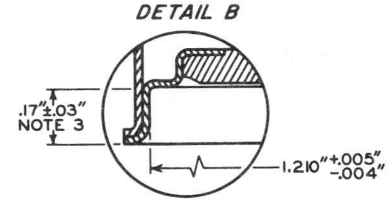
DIMENSIONAL OUTLINE



DETAIL A



DETAIL B



NOTE 1: RADIUS OF CURVATURE OF FACEPLATE IS 1.230" ± 0.005". FACEPLATE THICKNESS AT CENTER IS 0.030" ± 0.005".

NOTE 2: FIVE INSULATED LEAD TIPS WILL NOT EXTEND BEYOND MAXIMUM O.D. OF TUBE. LEADS ARE USED ONLY DURING TUBE MANUFACTURE.

NOTE 3: DEPTH IS MEASURED TO TANGENT OF THE TWO RADII.

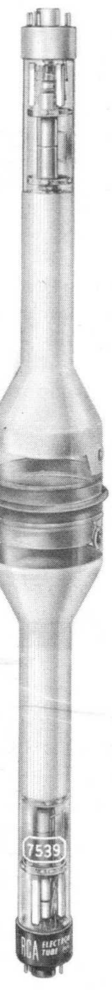
7539

GRAPHECHON

Scan-Conversion Storage Tube

Writing Gun:	Magnetic Deflection Electrostatic Focus	Bombardment-Induced- Conductivity Writing	26" Max. Length 3.4" Max. Diameter
Reading Gun:	Magnetic Deflection Magnetic Focus	Capacitance-Charge Reading	Coaxial Construction Two Duodecal Bases

RCA-7539 is a sturdy charge-storage tube designed for use in data-processing applications where signal information must be continuously transformed, with minimum loss in detail, from one time base or scanning presentation to another. In addition, the 7539 provides a means of obtaining bright displays having a continuous range of halftone information under conditions of high ambient illumination.



In a typical systems application, PPI (Plan Position Indicator) information generated by radar installations is transformed by the 7539 into TV-type signals so that the information can be viewed on direct-view and projection television monitors. If desired, a large number of such monitors may be used to repeat the display at locations remote from the master-display unit. For example, the 7539 may be used in airport-surveillance applications where aircraft-traffic-condition information may be sent over ordinary TV-type distribution systems to distant cities. Also, information from several radar installations as well as ground-map or special command information picked up by TV cameras may be readily mixed and presented as a composite display.

The characteristics of the 7539 are such that the stored information may be extracted and displayed at high-brightness levels for a period corresponding to many TV scanning frames. Depending on the signal-to-noise ratio required, this period may be adjusted from several seconds to more than a minute by suitable choice of tube operating voltages.

The resolution capability of the 7539 is 150 range rings per display radius with a response of 50 per cent or better. To utilize fully the resolution capability of the 7539, the TV monitor system must be designed for resolution in excess of 1000 TV lines.

Design features of the 7539 include a sturdy construction utilizing special bulb supports, glass beading which locks the electrodes in permanent relation to each other, and a precision alignment of the coaxial elements. These features insure both dependable performance and close uniformity in characteristics from tube to tube. Another feature of the 7539 is the use of small recessed cavity caps as envelope terminals.

PRINCIPLES OF OPERATION

The 7539 has three sections—a writing section, a reading section, and a target section—as shown in Fig.1.

Writing Section

The writing section contains an electron gun consisting of an indirectly heated cathode, a control grid (grid No.1), an accelerating grid (grid No.2), a focusing grid (grid No.3), and a final accelerating electrode (grid No.4) connected to the external conductive coating. The writing gun produces a high-velocity electron beam which is focused electrostatically and deflected by the magnetic fields of external deflecting coils.

Reading Section

The reading section contains an electron gun consisting of an indirectly heated cathode, a control grid (grid No.1), and an accelerating grid (grid No.2). The reading gun produces a

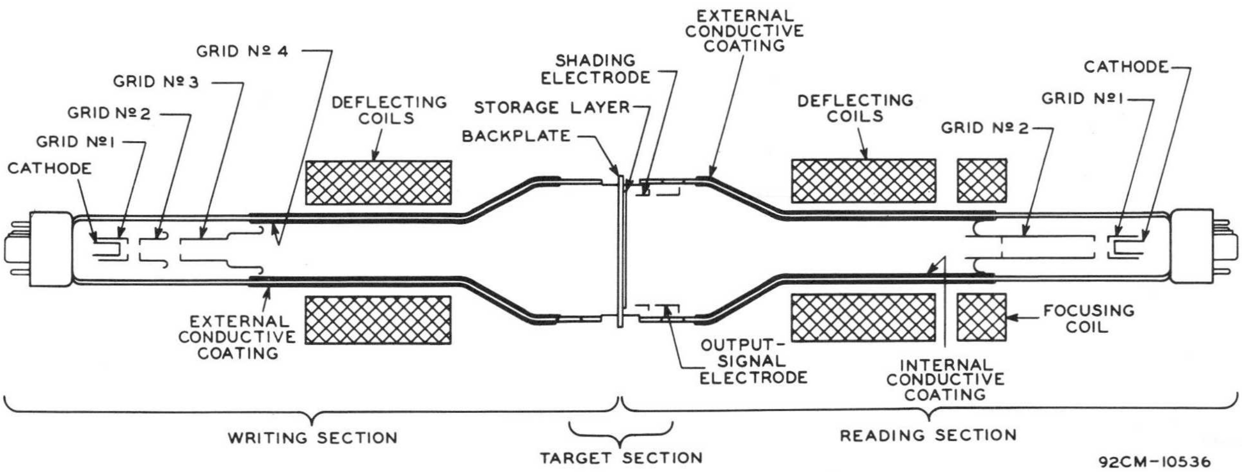


Fig. 1 - Schematic Arrangement of Type 7539.

medium-velocity electron beam which is focused and deflected by the magnetic fields of external focusing and deflecting coils.

Target Section

The target section contains a target, a shading-electrode, and an output-signal electrode. The target consists of a very thin layer of a high-resistivity material deposited on the front—the reading-gun side—of the backplate. The backplate is composed of an extremely thin layer of metal deposited on the reading-gun side of a very fine metal mesh. The backplate allows high transmission of incident writing-beam electrons. The thin layer of high-resistivity material is called the storage layer. The storage layer, under normal operating conditions, has a secondary emission ratio greater than unity. The storage layer also serves as a dielectric for the capacitor formed between the backplate and the front surface of the storage layer.

When the front surface of the storage layer is bombarded by the medium-velocity electron beam of the reading gun, secondary electrons are emitted. As the secondary-electron emission ratio of the front surface is greater than unity, the surface begins to charge in the positive direction. Under continued bombardment, the surface becomes increasingly positive with respect to the output-signal electrode until a retarding potential of a few volts is built up and equilibrium is established.

The opposite side of the storage layer—the back side—is in mechanical and electrical contact with the backplate. Because the backplate is at a negative potential with respect to the output-signal electrode, a difference of potential exists between the two surfaces of the storage layer during conditions of equilibrium. During the writing process, the high-velocity electron beam bombards the target. It passes through the backplate and penetrates the storage layer. The resulting bombardment-induced-conductivity produced in the storage layer lowers the potentials of the front surface elements by varying degrees toward the negative potential of the backplate. The front surface of the storage layer thus acquires a pattern of potential variations which corresponds to the input video signal. When the writing beam is removed, the storage layer gradually regains normal resistivity.

Because the output signal from any given area of the storage layer is a continuous function of the input signal, providing that area is not written beyond saturation, storage of a continuous range of halftone information is possible.

The writing or discharging characteristic of the 7539 is a function of writing-beam current, writing-beam velocity, scanning speed, and width as well as repetition rate of the input-pulse signal.

The change in potential of the storage-surface elements caused by writing-beam bombardment upsets the equilibrium conditions established by the reading beam. Secondary electrons, produced by reading-gun bombardment of the storage-surface elements that have been driven toward the negative backplate voltage by writing, are now accelerated to the output-signal electrode and constitute the output-signal current. The reading process, therefore, serves as an erasing process by removing the stored potential pattern and driving the storage surface back toward the equilibrium value. Because the storage layer does not immediately regain its normal resistivity after the writing beam is removed, and because there is relatively large capacitance between the front surface and the back surface of the storage layer, a large number of scans are required before equilibrium is reestablished. The stored signal accordingly "persists" for some time.

The reading or charging characteristic of the 7539 is a function of backplate potential and reading-gun current. Increasing backplate potential and decreasing reading-beam current result in increased charging time. By suitably adjusting these operating values, the reading time can be varied from a few seconds to over a minute.

Because the reading process removes the stored-charge pattern and brings the storage-surface elements to the equilibrium potential essential for writing, an erasing process is not ordinarily required.

The maximum number of scanning frames (copies) obtainable during the reading process depends on the magnitude of the potential variations produced on the storage-surface elements during the writing process, and the minimum value of reading-beam current that can be used in relation to the noise level of the associated amplifier.

The shading-electrode is used to reduce variation in the equilibrium potential of the storage-surface elements as a function of their location on the surface. As a result of its action, the output signal is relatively free from the effect commonly called "shading". The shading-electrode is operated at a potential somewhat positive with respect to that of the backplate.

DATA

General:

	Writing Gun	Reading Gun	
Heater, for Unipotential Cathode:			
Voltage (AC or DC). . .	6.3 ± 10%	6.3 ± 10%	volts
Current at 6.3 volts. .	0.6	0.6	amp
Direct Interelectrode Capacitances:			
Grid No.1 to all other electrodes. . .	7	6	μμf
Cathode to all other electrodes	4.8	5	μμf
Output-signal electrode to all other electrodes. . .	15		μμf
Backplate to all other electrodes. . .	26		μμf
Focusing Method	Electrostatic	Magnetic	
Deflection Method	Magnetic	Magnetic	
Deflection Angles (Approx.)	30°	30°	

Overall Length. . . . . 25.5" ± 0.5"

Maximum Diameter. . . . . 3.40"

Minimum Useful Target Diameter. . . . . 2.25"

Base:

Writing Gun . . . . . .Tan—Small-Shell Duodecal 7-Pin, Arrangement 1, (JEDEC No.B7-51)

Reading Gun . . . . .Black—Small-Shell Duodecal 6-Pin, Arrangement 1, (JEDEC No.B6-63)

Socket (For either base). . . . . . Alden★ No.212FTSC, or Cinch★★ No.9464-12, or equivalent

Bulb Terminals:

Cap (Three) . . .Recessed Small Cavity (JEDEC No.J1-21)

Flange. . . . . See *Dimensional Outline*

Operating Position. . . . . Tube Axis Horizontal, or with the Black-Base End Down

Weight (Approx.). . . . . 1.2 lbs

Maximum and Minimum Ratings, *Absolute-Maximum Values:*♦

OUTPUT-SIGNAL ELECTRODE-TO-BACKPLATE VOLTAGE:		
Positive value.	100 max.	volts
Negative value.	10 max.	volts
OUTPUT-SIGNAL ELECTRODE-TO-SHADING-ELECTRODE VOLTAGE	100 max.	volts
OUTPUT-SIGNAL ELECTRODE-TO-GRID-No.2 (Reading Gun) VOLTAGE .	100 max.	volts
OUTPUT-SIGNAL ELECTRODE-TO-EXTERNAL CONDUCTIVE COATING (Reading Gun) VOLTAGE	100 max.	volts
SHADING-ELECTRODE-TO-BACKPLATE VOLTAGE	100 max.	volts
SHADING-ELECTRODE-TO-EXTERNAL CONDUCTIVE COATING (Reading Gun) VOLTAGE	100 max.	volts
BACKPLATE-TO-GRID-No.4 (Writing Gun) VOLTAGE	100 max.	volts

Voltages are referred to cathode of respective gun unless otherwise indicated

	Writing Gun	Reading Gun	
GRID-No.4 VOLTAGE . . .	11000 max.	–	volts
GRID-No.3 VOLTAGE . . .	3000 max.	–	volts
GRID-No.2 VOLTAGE . . .	300 max.	2500 max.	volts
GRID-No.1 VOLTAGE:			
Negative bias value .	180 max.	0 max.	volts
	*	0 min.	volts
PEAK HEATER-CATHODE VOLTAGE:§			
Heater negative with respect to cathode.	125 max.	125 max.	volts
Heater positive with respect to cathode.	10 max.	10 max.	volts

Typical Operating Conditions and Characteristics:

Voltages are referred to ground⊕ unless otherwise indicated

	Writing Gun	Reading Gun	
Grid-No.4 Voltage . . .	0	–	volts
Grid-No.3 Voltage for Focus	-7000 to -9000	–	volts
Grid-No.2 Voltage . . .	-9800	0 to -30#	volts
Grid-No.1-to-Cathode Voltage for Beam-Current Cutoff. . . .	-40 to -100	-40 to -100	volts
Cathode Voltage	-10,000	-2000	volts
Cathode Current:			
Maximum Operating Value (Approx.) . .	50□	200	μa
Maximum Zero-Bias Value	▲	3.8	ma
Focusing-Coil Current□□	–	23	ma
Backplate Voltage♦. . .	-4 to -7		volts
Shading-Electrode Voltage	10		volts
Output-Signal-Electrode Voltage	0		volts

Maximum Circuit Values:

	Writing Gun	Reading Gun	
Grid-No.1-Circuit Resistance.	1.5 max.	1.5 max.	megohms

Characteristics Range Values for Equipment Design:

	Note	Min.	Max.	
Peak Output-Signal Current. . . .	1	0.3	–	μa
Relative Response of Output Video Signal.	2	50	–	%
Maximum Time to Erase Stored Signal to 10% of Value Immediately Following Writing .	–	–	30	sec
Minimum Number of Discernible Output-Signal Levels.	3	4	–	
Storage Factor for Essentially Saturated Writing	1,4	3	–	μa-sec

Note 1: Under the following conditions: The writing-gun beam is modulated with pulses whose half-amplitude

duration is between 0.5 and 1.0 microsecond. The modulated beam scans the back side of the target to produce a PPI display of 150 concentric rings. The 150th ring utilizes the maximum usable diameter of the storage-tube target.

PPI radial-scan repetition rate. . .	1000	cps
PPI radial range period.	610	μsec
PPI scan rotational rate (Approx.) .	6	rpm

The reading-gun beam scans the front side of the target to produce a square raster whose usable edges (exclusive of blanked portions) are tangent to the usable target circumference.

Vertical scan rate	60	cps
Horizontal scan rate	28350	cps
Frames per second.	30	
Fields per frame (Interlaced). . . .	2	
Lines per frame.	945	
Active field time.	90	%
Active line time	83	%
Aspect ratio	1	

The reading-beam current and/or backplate voltage is adjusted so that the output signal from the range rings drops to approximately 50% of its initial level in one PPI rotational period.

Note 2: Relative response of output video signal is defined by the expression h/H in per cent where "H" is the peak-to-peak value of output signal produced when the reading beam is scanning a 35-concentric-ring display immediately following writing and "h" is the peak-to-peak value of output signal produced when the reading beam is scanning a 150-concentric-ring display immediately following writing. This ratio is determined under the same writing and reading conditions of Note 1 except the writing section is initially scanned to produce the PPI display on the target of 35 concentric rings and then, after erasure, is scanned to produce the PPI display on the target of 150 concentric rings.

Note 3: The minimum number of discernible output-signal levels is defined as the number of output-signal levels, each related to a different input signal, which can be just distinguished from each other regardless of their relative location on the storage surface.

Note 4: Storage factor is defined as the product of the initial value of the peak amplitude of the output-signal current (above background or equilibrium level) and the time required for the peak amplitude of the output-signal current to drop to 50% of its initial value.

★ Alden Products Company, 117 N. Main Street, Brockton, Mass.

★★ Cinch Manufacturing Corporation, 1026 S. Homan Avenue, Chicago 24, Illinois.

♦ The ***maximum ratings*** in the tabulated data are established in accordance with the following definition of the ***Absolute-Maximum Rating System*** for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

* Static bias-voltage value should never be less negative than value required for beam cutoff.

§ To prevent the possibility of inadvertantly exceeding these ratings, it is recommended that the cathode should be connected to the center tap or one side of heater transformer.

⊕ External conductive coatings of the 7539 should be grounded.

\# Adjust for optimum stored-signal uniformity.

□ Peak value. Average cathode current is much lower due to nature of radar video signals.

▲ Writing gun must never be operated at zero-bias voltage.

⊞ With Syntronic F10B Focusing Coil, or equivalent. Focusing-coil air-gap should be approximately 6.5" from target flange.

♦ Adjusted for desired storage-time characteristics.

OPERATING CONSIDERATIONS

Handling. The 7539 should preferably be transported or handled with either the black-base end down or with the tube axis horizontal to prevent any loose particles within the tube from striking the storage surface and adhering to it. Care should be taken to prevent striking the glass-to-metal seals. Such rough treatment will cause either immediate or delayed cracking of these seals.

Shielding. Electrostatic, magnetic, and light shielding are required by the 7539 for satisfactory performance.

Electrostatic shielding of the target section must be provided to prevent external radiation from causing spurious signals in the output circuit. This shield must make good electrical contact with the external conductive coatings of both the reading section and the writing section of the 7539. A suitable contact to each of the external conductive coatings can be provided by phosphor-bronze spring-finger ring contacts close to and on each side of the backplate flange. Holes for terminal leads should be made through the shield material.

Magnetic shielding of the 7539 and its focusing coil and deflecting coils must also be provided to prevent external magnetic fields from affecting the writing-gun beam and the reading-gun beam, and therefore, tube performance. The amount and nature of the shielding necessary is dependent on the location and intensity of the magnetic fields produced by the components of associated equipment. The use of a canister-type shield made of a high-permeability material is suggested. The canister wall should be at least 1/32" thick with provisions for adding additional layers of shielding material if they are required.

Light shielding, which may be provided by either the electrostatic or magnetic shielding, is necessary because the storage-layer material of the target is photoconductive. Failure to provide adequate light shielding for the 7539 results in unstable output-current storage-time characteristics and unsatisfactory erasing performance.

Operating Position. The 7539 may be operated either horizontally or vertically with the black-base end down. Support for the 7539 can be effected by mounting the tube on a set of right-angle "V" blocks within the magnetic shield. Suitable straps may hold the tube in place. Care must be taken, however, not to exert excessive radial forces on the glass necks of the tube. The V-blocks should be of a non-magnetic material and should support the tube at no more than two axial positions.

Terminal Connections. The pins of both the black and the tan duodecal bases fit a duodecal socket. Connection to the backplate flange may be made by a spring-loaded contact bearing against the rim of the flange. Connections to the output-signal electrode, the shading electrode, and grid No.4 of the writing-gun section are made to recessed small cavity caps.

Deflection Considerations. The writing beam may be deflected by either a mechanically rotating pair of coils diametrically opposite each other or by two stationary pairs of coils. In the latter case, one pair is used for horizontal deflection; and the other, for vertical deflection.

When a rotating pair of coils is used, centering of the undeflected writing beam, as required for a PPI scan, may be accomplished by means of a centering device of either the electromagnetic or permanent-magnet type. This device is mounted on the writing-gun neck behind the rotating deflecting coils.

When stationary coils are used, centering of the undeflected writing beam is preferably accomplished by passing direct current of the required value through each pair of deflecting coils.

Application will govern the choice of deflecting yokes for the reading and writing guns. It is recommended that equipment designers select yokes providing deflection angles of at least 50° even though the tube requires substantially less deflection. The use of deflecting coils providing at least 50° deflection minimizes cross-sectional beam-distortion effects.

For PPI to TV-scan conversion, any of the deflecting coils in the Syntronic* Y15-5, Y17-5, Y25-R or Y27-R series, or their equivalents, are suggested for the writing gun. Deflecting coils in the Syntronic Y16-6 series, or equivalents, are suggested for the reading gun.

Positioning of the Deflecting Coils and Focusing Coil. Because the glass necks of the 7539 have mutual axial alignment and in turn are each aligned with the undeflected beams of the writing and reading guns, the external deflecting coils and the focusing coil must be mounted coaxially with the necks to prevent distortion in the scan-conversion process. Interference to writing-gun and reading-gun beam formation by the magnetic fields of these coils is minimized if the axial-position limitations shown in Fig.2 are observed.

Having noted these limitations, the designer may position the deflecting coils and the focusing coil where they may best serve the requirements of this particular system, keeping in mind the following considerations:

1. Power requirements for the deflecting coils increase as the yokes are moved closer to the backplate flange.
2. Cross-sectional beam-distortion effects resulting from off-axis deflection increase as the yokes are moved closer to the backplate flange. If yokes designed for 50° total deflection angle or more are used, this consideration is of secondary significance.
3. Resolution capabilities of the 7539 are slightly improved as the reading-gun focusing coil is moved closer to the backplate flange.
4. The overall effect of pattern distortions associated with beam scanning of a flat target is minimized if the effective deflection center of each yoke is located equidistant from the backplate flange.
5. Depending on the physical and electrical configurations of the reading-gun deflecting coils and the focusing coil chosen, moderate spacing between these components should be used.

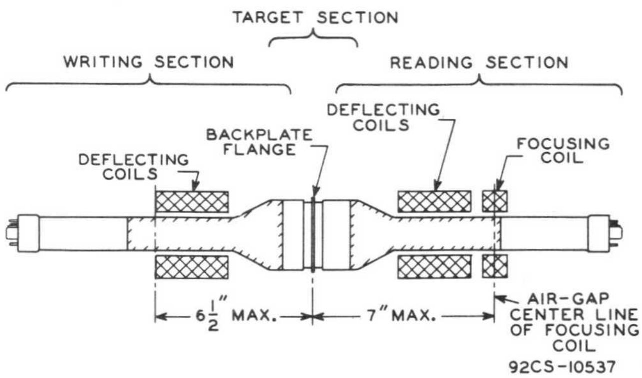


Fig. 2 - Limitations to be Observed in Positioning External Deflecting and Focusing Coils for Type 7539.

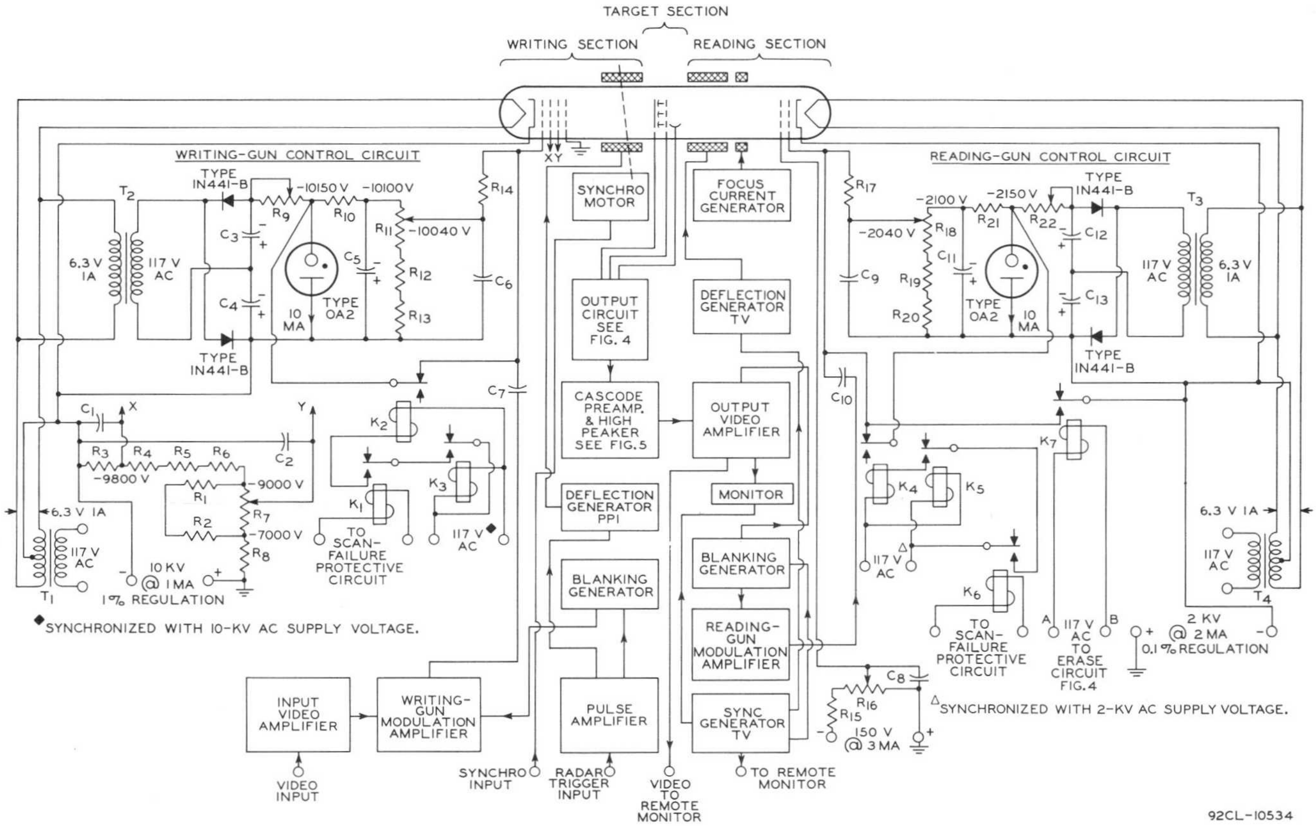
Power-Supply and Gun-Control Considerations. Typical power-supply and gun-control circuits for use with the 7539 are shown in Fig.3. This figure also shows in block-diagram form the associated equipment required for operation of the 7539.

The coupling capacitors C_7 and C_{10} of the writing- and reading-gun control circuits have much higher voltage ratings, and therefore are larger, than the capacitors normally encountered in video circuitry. Stray wiring capacitance in these circuits should be minimized by using short, direct leads wherever possible.

The external conductive coatings of the 7539 should be grounded not only for safety reasons, but also to prevent excessive pickup of noise by the target section.

Because the cathodes of both guns are at high negative voltages, the transformers used to supply current to the heaters as well as the

* Syntronic Instruments, Inc., 100 Industrial Road, Addison, Illinois.



All resistors may have tolerance of ±10 per cent unless otherwise indicated

C_1: 0.1 μf, paper, 400 v working voltage
C_2: 0.1 μf, plastic film, 5 kv working voltage
C_3, C_4: 20 μf, electrolytic, 150 v working voltage
C_5: 4 μf, electrolytic, 150 v working voltage
C_6: 0.5 μf, paper, 200 v working voltage
C_7: 0.05 μf, plastic film, 15 kv working voltage
C_8: 1 μf, paper, 100 v working voltage
C_9: 0.1 μf, paper, 200 v working voltage
C_{10}: 0.1 μf, plastic film, 3 kv working voltage
C_{11}: 4 μf, electrolytic, 150 v working voltage
C_{12}, C_{13}: 20 μf, electrolytic, 150 v working voltage
K_1: S.P.S.T. relay, normally open. Voltage rating is dependent on particular scan-failure circuit used.
K_2: S.P.S.T. vacuum relay, normally closed. Insulated for 15 kv.
K_3: S.P.S.T. relay, 10-second time-delay, normally open, 117 v ac
K_4: S.P.S.T. relay, normally closed, 117 v ac. Insulated for 3 kv.
K_5: S.P.S.T. relay, 10-second time-delay, normally open, 117 v ac
K_6: S.P.S.T. relay, normally open. Voltage rating is dependent on particular scan-failure circuit used.
K_7: S.P.S.T. relay, normally open, 117 v ac. Insulated for 3 kv.

R_1: 2 megohms, 5 watts, 2500 volts
R_2: 300000 ohms, 2 watts
R_3, R_4: 200000 ohms, 1 watt
R_5, R_6: 300000 ohms, 1 watt
R_7: 15-megohm potentiometer, IRC type HV-15, or equivalent
R_8: 7 megohms, 25 watts, 10000 volts
R_9: 10000 ohms, 10 watts, adjustable
R_{10}: 82000 ohms, 1/2 watt
R_{11}: 100000-ohm potentiometer, 1/2 watt. Bias-voltage control.
R_{12}, R_{13}: 33000 ohms, 1/2 watt
R_{14}: 1 megohm, 1 watt
R_{15}: 39000 ohms, 1 watt
R_{16}: 10000-ohm potentiometer, 1/2 watt. Uniformity control.
R_{17}: 1 megohm, 1 watt
R_{18}: 100000-ohm potentiometer, 1/2 watt. Bias-voltage control.
R_{19}, R_{20}: 33000 ohms, 1/2 watt
R_{21}: 82000 ohms, 1/2 watt
R_{22}: 10000 ohms, 10 watts, adjustable
T_1: Heater transformer with secondary insulated for 15 kv.
T_2, T_3: Heater transformer
T_4: Heater transformer with secondary insulated for 3 kv.

Fig.3 - Typical Power-Supply and Gun-Control Circuits with Block Diagram of Associated Equipment for Type 7539.

sources of control-grid signals must be adequately insulated from ground. It is recommended that the cathode of each gun be connected directly to the mid-tap of its associated heater winding.

The high voltages at which the 7539 is operated may be very dangerous. Great care should be taken in the design of apparatus to prevent the operator from coming in contact with the high voltages. Safety precautions include the enclosing of high-potential terminals and the use of interlocking switches to break the primary circuit of the power supply when access to the equipment is desired.

In the use of high-voltage tubes, it should always be remembered that high voltages may appear at normally low-potential points in the circuit as a result of capacitor breakdown or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned off, and both terminals of any capacitors grounded.

Failure of Scanning. Failure of scanning while either beam is turned on may permanently damage the target. Provision should therefore be made to cut off beam current of both guns automatically in case of scanning failure. Cutoff may be effected by making the control grids—grid No.1 of the writing gun and the reading gun—sufficiently negative with respect to the gun cathodes. The beams must be cut off nearly as rapidly as the decrease in scanning current occurs. The protective circuit for the 7539 should be capable of cutting off the writing beam and the reading beam within 50 milliseconds after scanning failure. The protective circuit may be actuated by a tube that is controlled by a portion of the scanning pulse voltage developed across the deflecting coils. It is important that the horizontal and vertical scanning each independently actuate the protective circuit in case either should fail.

Regulation of Bias Supplies. Because the output signal and reading duration are critically dependent on the beam current of both the reading gun and the writing gun, it is essential that grid-No.1 bias supplies have good regulation if variations in output signal and in reading duration are to be avoided. In addition, the voltage supply providing the writing-beam accelerating potential must have substantially less ripple than is permitted in ordinary cathode-ray tube circuits. Ripple in this supply should be kept to a value substantially less than 0.1 volt.

Crosstalk. At a writing-gun accelerating-electrode (Grid No.4) voltage of 10 kilovolts, less than 20 per cent of the writing-beam current appears in the output-signal electrode circuit. For most applications, writing beam current is low and feed-through is not discernible in the output display. However, if cancellation of crosstalk is desired, simple mixing, in opposite phase or polarity, of a writing-beam sample with the output signal of the tube should be adequate. RF carrier separation techniques need not be used. Operating the writing gun of the 7539 at reduced accelerating voltages also reduces crosstalk to a negligible value but this procedure also reduces tube resolution.

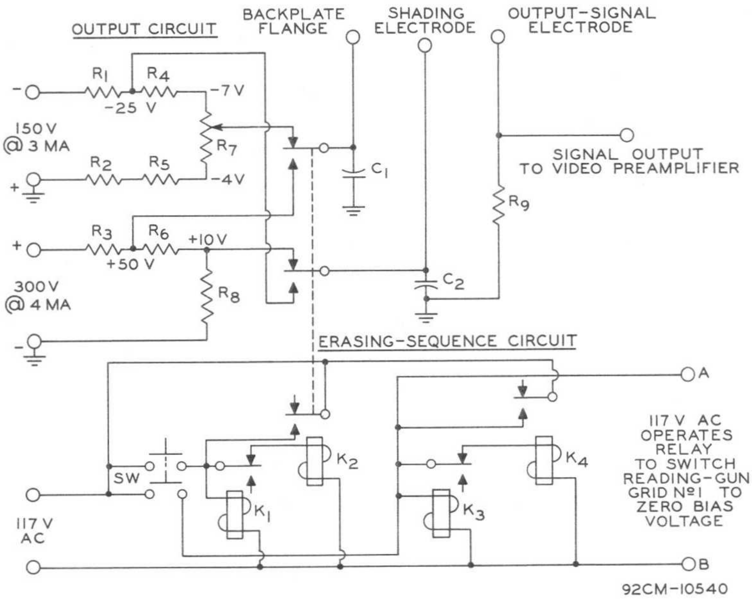
Reading Duration Control.. Reading duration may be adjusted by control of reading-beam current and to a lesser degree by control of backplate voltage. The basic control of this performance characteristic should be effected by adjustment of reading-gun beam current.

Erasure. Ordinarily there is no need to program an erasing sequence but under certain conditions—such as radar-range changes—rapid clearing of information may be desirable. The following procedure should be used for erasure:

1. Simultaneously adjust backplate voltage to +50 volts, shading-electrode voltage to -25 volts, and the reading-gun grid-No.1 bias voltage to 0 volts.
2. After a 10-second interval, readjust backplate- and shading-electrode voltages to their normal operating voltages.
3. Allow a 10-second interval before readjusting the reading-gun grid-No.1 bias voltage to its normal operating voltage.
4. An additional 10-second delay permits associated equipment to regain stability.

As indicated in Fig.4, the erasing sequence may be effected by using time-delay relay circuitry.

Video-Drive Considerations. Information to be stored by the 7539 should be applied as a video signal to the control grid (grid No.1) or the cathode of the writing gun. Video signals are treated the same as if they were to be displayed on ordinary cathode-ray display tubes. Grid-No.1 bias voltage is first adjusted to cut-off completely writing-beam current. An unblanking pulse, coincident in time with the writing-beam scanning waveform, is then applied to grid No.1 to allow the writing-beam current to reach the threshold of writing. For PPI displays, a larger writing-beam current is required to obtain this threshold at the edges of the PPI pattern than is required at the center. The necessary current waveshape is obtained by additively mixing a sawtooth waveform with the basic rectangular unblanking pulse. The amplitude of the sawtooth component depends on the range and azimuth repetition rates, and the scanning times associated with the particular radar system. The video signal may be either mixed with this composite unblanking signal and applied to grid No.1 of the writing gun, or the video signal may be applied directly to the cathode of the writing gun with the composite unblanking signal applied to grid No.1 of the writing gun. Regardless of the method used, the amplitude of the video signal is dependent on the particular parameters of the radar system used.



All resistors may have tolerance of ±10 per cent unless otherwise indicated

C_1, C_2: 1 μf, paper, 100 v working voltage

K_1: S.P.S.T. relay, 10-second time-delay, normally closed, 117 v ac

K_2: 3 P.D.T. relay, 117 v ac

K_3: S.P.S.T. relay, 20-second time-delay, normally closed, 117 v ac

K_4: S.P.S.T. relay, normally open, 117 v ac

R_1: 43000 ohms, 1 watt

R_2: 1000 ohms, 1/2 watt

R_3: 62000 ohms, 2 watts

R_4: 6200 ohms, 1/2 watt

R_5: 330 ohms, 1/2 watt

R_6: 10000 ohms, 1/2 watt

R_7: 1000-ohm potentiometer, 1/2 watt. Storage-time control.

R_8: 2400 ohms, 1/2 watt

R_9: 47000 ohms, 1/2 watt. Representative value.

Sw: D.P.S.T. momentary contact (spring return), normally open. "Push-to-erase" switch.

Fig.4 - Output Circuit and Erasing-Sequence Circuit for Type 7539.

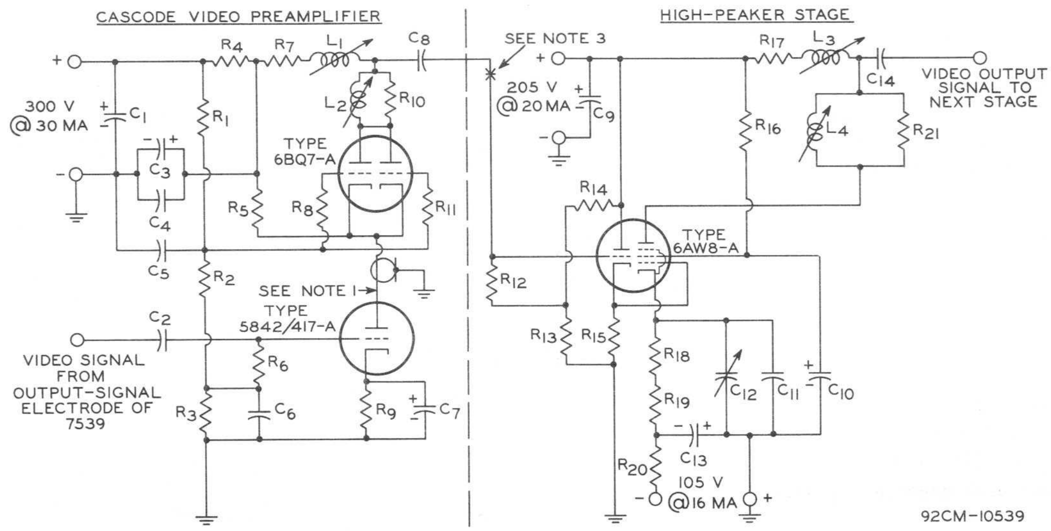
Video-Amplifier Circuitry. Typical video amplifier circuits for the 7539 are shown in Fig.5. In most applications, the peak-to-peak output signal current of the 7539 is in the order of tenths of a microampere. Video amplifiers should, therefore, be designed for high gain and low noise. A cascode-type preamplifier followed by appropriate high-peaker stages is highly recommended because of the extremely low equivalent-noise-input current that can be realized with this type of amplifier system. For example, such a system designed for a noise-equivalent bandwidth of 18 Mc may have an equivalent-noise-input current of less than 0.02 microampere rms value. An amplifier having a noise-equivalent-bandwidth of at least 18 Mc is necessary to fully utilize the capabilities of the 7539 in scan-conversion systems employing 945 lines per frame and 30 frames per second.

The designer may wish to add one or more video-amplifier stages between the cascode pre-amplifier and the high-peaker stage. It is good practice to amplify the output signal from the cascode preamplifier to a high level—avoiding overload conditions—before feeding the signal into the high-peaker stage. In Fig.5 the output signal of the preamplifier stage is approximately 0.25 volt. If additional amplification is desired, one or two video-amplifier stages each having a gain of 5 are recommended.

SET-UP PROCEDURE

The following steps should be followed when first placing the 7539 in operation:

1. Insert the 7539 in its mount, position the external deflecting and focusing coils, and attach sockets.
2. Make certain that the deflection circuits are functioning properly to cause the beams to scan the target.
3. Be sure the grid-No.1 voltage of each gun is adjusted beyond beam cutoff and then apply voltages as indicated under *Typical Operation*. This procedure is essential to avoid possible damage to the target.
4. Adjust the reading-gun grid-No.1 bias voltage so that a picture of the 7539 target becomes visible on the system display monitor.
5. Adjust reading-beam deflection circuitry as required. In a typical PPI to TV system, the edges of the useful target area should lie tangent to the reading raster.
6. Adjust reading-gun focusing-coil current for sharpest picture of the 7539 target as seen on the system display monitor.
7. Set backplate voltage to -4 volts and reading-gun grid-No.2 voltage to -25 volts.
8. Without applying the input video signal,



All resistors may have tolerance of ±10 per cent unless otherwise indicated

C_1: 10 µf, electrolytic, 450 v working voltage
C_2: 0.1 µf, paper, 100 v working voltage
C_3: 10 µf, electrolytic, 450 v working voltage
C_4: 0.01 µf, paper, 400 v working voltage
C_5: 0.22 µf, paper, 200 v working voltage
C_6: 0.001 µf, ceramic disc, 600 v working voltage
C_7: 500 µf, electrolytic, 25 v working voltage
C_8: 0.22 µf, paper, 400 v working voltage
C_9, C_{10}: 40 µf, electrolytic, 250 v working voltage
C_{11}: 150 µf, mica, 500 v working voltage
C_{12}: 20 to 200 µµf, ceramic trimmer, 500 volts. This trimmer provides compensation over a range of 30 to 50 µµf for the high-frequency-response attenuation caused by the capacitance at the 5842/417-A grid.
C_{13}: 300 µf, electrolytic, 150 v working voltage
C_{14}: 0.1 µf, paper, 400 v working voltage
L_1: 5 µh
L_2: 10 µh
L_3: 5 µh
L_4: 10 µh
R_1: 330000 ohms, 1/2 watt
R_2: 270000 ohms, 1/2 watt
R_3: 47000 ohms, 1/2 watt
R_4: 750 ohms, 2 watts
R_5: 12000 ohms, 2 watts
R_6: 510000 ohms, 1/2 watt
R_7: 750 ohms, 2 watts
R_8: 200 ohms, 1/2 watt
R_9: 680 ohms, 1 watt
R_{10}: 4700 ohms, 1/2 watt
R_{11}: 200 ohms, 1/2 watt
R_{12}: 1 megohm, 1/2 watt
R_{13}: 82000 ohms, 1/2 watt
R_{14}: 1 megohm, 1/2 watt
R_{15}: 5600 ohms, 1/2 watt
R_{16}: 22000 ohms, 1 watt
R_{17}: 750 ohms, 1 watt
R_{18}, R_{19}: 3600 ohms, 2 watts, 5 per cent tolerance
R_{20}: 1000 ohms, 1/2 watt, 5 per cent tolerance
R_{21}: 4700 ohms, 1/2 watt

NOTE 1: BECAUSE THIS IS A LOW-IMPEDANCE PART OF THE CIRCUIT, THE 5842/417-A SHOULD BE LOCATED CLOSE TO THE 7539 TO PERMIT USE OF A SHORT, DIRECT INPUT LEAD TO MINIMIZE STRAY INPUT CAPACITANCE. THE CONNECTION FROM THE 5842/417-A PLATE TO THE 6BQ7-A CATHODE MAY BE A LOW-IMPEDANCE CABLE UP TO 18" IN LENGTH.

NOTE 2: VALUES SHOWN FOR L_1, L_2, L_3, L_4, R_7, R_{10}, R_{17}, AND R_{21} ARE APPROXIMATE VALUES FOR AN AMPLIFIER BANDWIDTH OF 15 MC. THE INDUCTORS SHOULD BE SLUG-TUNED FOR INDIVIDUAL TRIMMING OF THE FREQUENCY RESPONSE CHARACTERISTIC.

NOTE 3: THE INDIVIDUAL DESIGNER MAY WISH TO ADD ONE OR MORE ADDITIONAL VIDEO-AMPLIFIER STAGES BETWEEN THE CASCODE PREAMPLIFIER AND THE HIGH-PEAKER STAGE.

Fig.5 - Typical Video Preamplifier Circuit and High-Peaker Amplifier Circuit for Type 7539.

adjust writing-gun grid No. 1 and/or unblanking signal level so that bombardment of the 7539 target by the writing beam is just evident.

9. Adjust writing-beam deflection circuitry as required.

10. Adjust the shape of the sawtooth waveform which is superimposed on unblanking pulse and concurrently adjust writing-gun grid-No. 1 bias voltage for threshold writing over all areas encompassed by the writing scanning pattern.

11. Adjust reading-gun grid-No. 1 bias voltage so that writing is just below threshold.

12. Apply video signals (e.g. range marks) to produce writing pattern. Adjust input video-signal amplitude to a value just below that which produces visual evidence of crosstalk on system display monitor.

13. Adjust writing-gun grid-No.3 voltage for best focus of writing pattern as seen on system display monitor.

14. Readjust reading-gun grid-No.2 voltage for minimum variation of intensity of output signals. At optimum value of reading-gun grid-No.2 voltage, the output display will show more detail than otherwise.

15. Apply video signal which is to be processed for display.

16. The reading-gun grid-No. I bias voltage may now be adjusted to give the desired reading duration (i.e. display persistence). Secondary control of reading duration may be effected by adjustment of backplate voltage within range shown under *Typical Operation*.

REFERENCES

L. Pensak, *"Picture Storage Tube"*, Electronics, Vol.22, No.7, pp.84-88 (July, 1949).

L. Pensak, *"The Graphechon—A Picture Storage Tube"*, RCA Review, Vol.X, No.1, pp.59-73 (March, 1949).

A.H. Benner and L.M. Seeberger, *"Graphechon Writing Characteristics"*, RCA Review, Vol.XII, No.2, pp.230-250 (June, 1951).

M. Knoll and B. Kazan, *"Storage Tubes and Their Basic Principles"*, John Wiley & Sons, Inc., New York, (1952).

DOS and DON'TS on Use of RCA-7539

Here are the "dos"—

1. **Handle the 7539 with care.**
2. **Use extreme caution when installing the 7539.**
3. **Be sure that both beams are always cut off before applying operating voltages.**
4. **Operate the reading gun first so that effects of subsequent writing-beam operation may be observed on monitor.**

Here are the "don'ts"—

1. **Don't strike glass-metal seals of the 7539.**
2. **Don't operate the 7539 without scanning.**
3. **Don't use excessive writing-beam current.**

The significance of each of these "dos" and "don'ts" in obtaining optimum performance from the 7539 is explained in the preceding pages of this bulletin.

	Writing Gun	Reading Gun
E_f = 6.3 VOLTS—EACH GUN		
BACKPLATE VOLTS* = -5		
OUTPUT-SIGNAL-ELECTRODE VOLTS* = 0		
SHADING-ELECTRODE VOLTS* = +10		
GRID-Nº 4 VOLTS*	0	—
GRID-Nº 3 VOLTS*	ADJUSTED FOR BEST FOCUS	—
GRID-Nº 2 VOLTS*	-9800	ADJUSTED FOR MOST UNIFORM DISPLAY
GRID-Nº 1 VOLTS*	ADJUSTED FOR THRESHOLD OF WRITING IN ABSENCE OF VIDEO-INPUT SIGNAL	ADJUSTED FOR READING DURATION AS SHOWN
CATHODE VOLTS*	-10000	-2000
FOCUSING-COIL MA	—	ADJUSTED FOR BEST FOCUS
SCANNING:	PPI	TV
RADIAL REPETITION RATE (CPS)	1000	—
RADIAL RANGE PERIOD (μSEC)	610	—
ROTATIONAL RATE (RPM)	6	—
VERTICAL RATE (CPS)	—	60
HORIZONTAL RATE (CPS)	—	28350
VIDEO-INPUT SIGNAL:		
PULSE LENGTH (μSEC)	30	—
PEAK-TO-PEAK VOLTS ABOVE CUTOFF	5	—

*REFERRED TO GROUND.

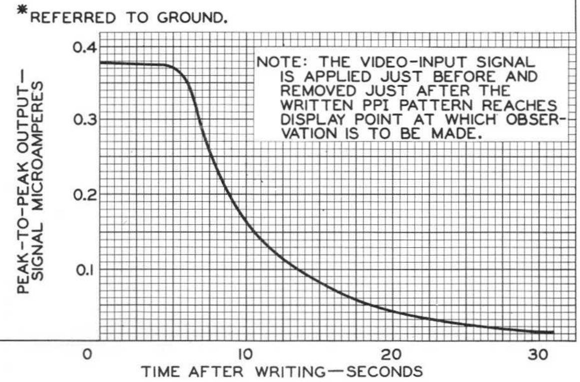


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Fig. 6 - Typical Storage Characteristic of Type 7539.

	Writing Gun	Reading Gun
E_f = 6.3 VOLTS—EACH GUN		
BACKPLATE VOLTS* = -5		
OUTPUT-SIGNAL-ELECTRODE VOLTS* = 0		
SHADING-ELECTRODE VOLTS* = +10		
GRID-Nº 4 VOLTS*	0	—
GRID-Nº 3 VOLTS*	ADJUSTED FOR BEST FOCUS	—
GRID-Nº 2 VOLTS*	-9800	ADJUSTED FOR MOST UNIFORM DISPLAY
GRID-Nº 1 VOLTS*	ADJUSTED FOR THRESHOLD OF WRITING IN ABSENCE OF VIDEO-INPUT SIGNAL	ADJUSTED FOR READING DURATION OF 10 SEC
CATHODE VOLTS*	-10000	-2000
FOCUSING-COIL MA	—	ADJUSTED FOR BEST FOCUS
SCANNING:	PPI	TV
RADIAL REPETITION RATE (CPS)	1000	—
RADIAL RANGE PERIOD (μSEC)	610	—
ROTATIONAL RATE (RPM)	6	—
VERTICAL RATE (CPS)	—	60
HORIZONTAL RATE (CPS)	—	28350
VIDEO-INPUT SIGNAL:		
PULSE LENGTH (μSEC)	0.75	—
PEAK-TO-PEAK VOLTS ABOVE CUTOFF	5	—

*REFERRED TO GROUND.

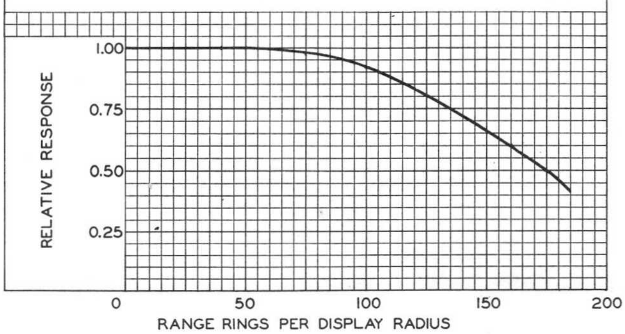

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Fig. 7 - Typical Resolution Characteristic of Type 7539.

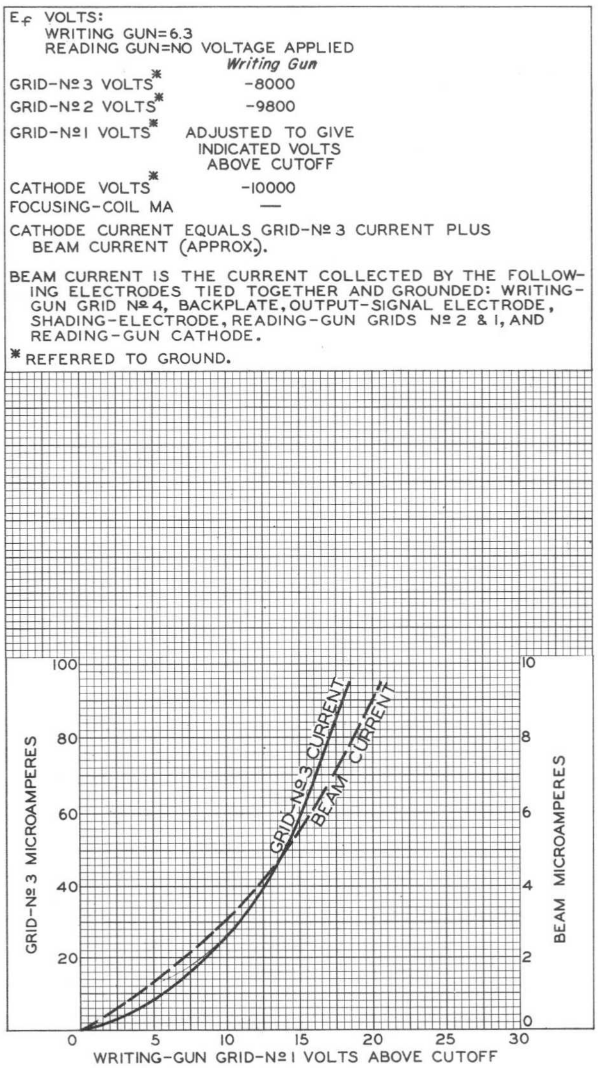

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Fig. 8 - Writing-Gun Control-Grid Characteristics of Type 7539.

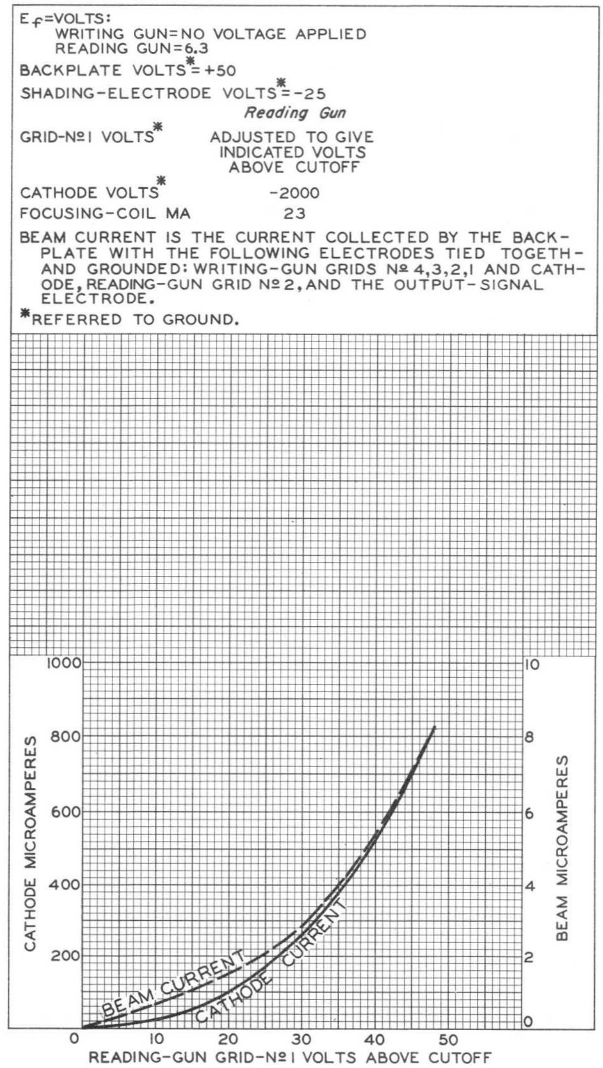

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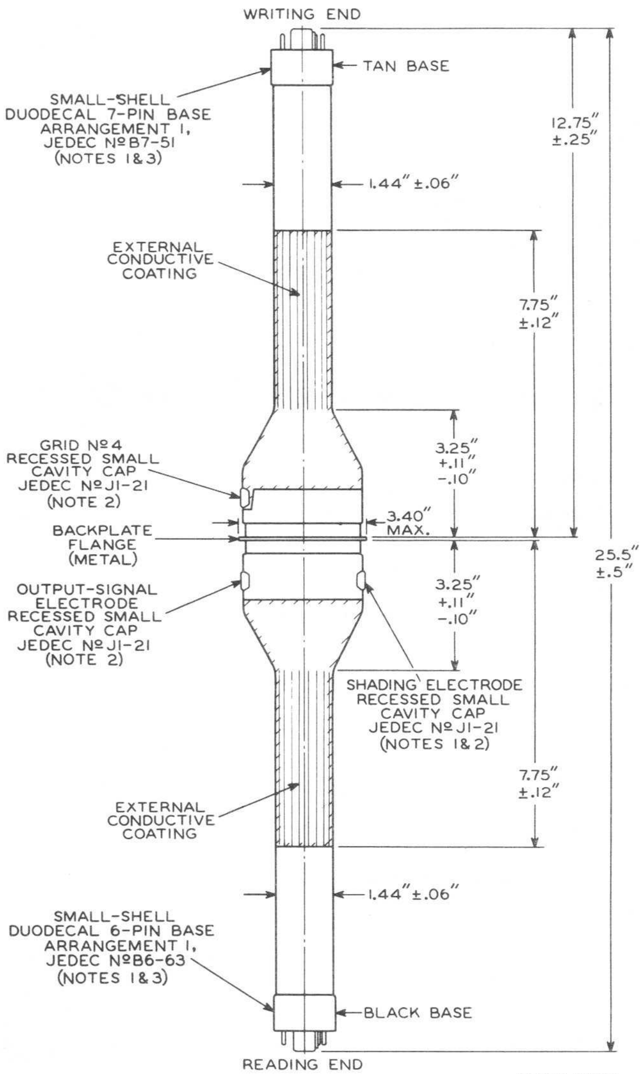
Fig. 9 - Reading-Gun Control-Grid Characteristics of Type 7539.

DIMENSIONAL OUTLINE



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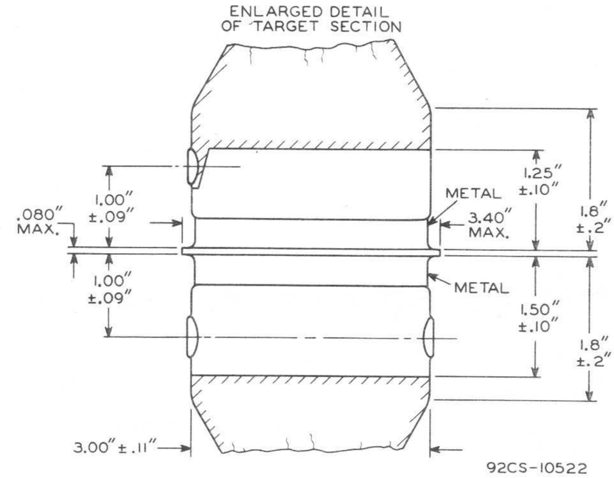

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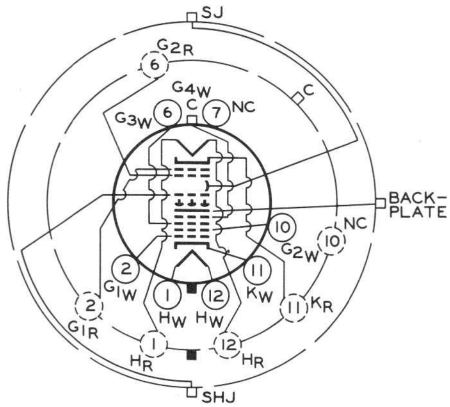
NOTE 1: THE PLANE THROUGH THE TUBE AXIS AND THE KEY OF EITHER DUODECAL BASE MAY VARY FROM THE PLANE THROUGH THE TUBE AXIS AND ℄ OF THE SHADING-ELECTRODE CAP BY AN ANGULAR TOLERANCE OF ±10° MEASURED ABOUT THE TUBE AXIS.

NOTE 2: THE PLANE THROUGH ℄ OF THE OUTPUT-SIGNAL-ELECTRODE CAP AND GRID-No. 4 CAP MAY VARY FROM THE PLANE THROUGH ℄ OF THE SHADING-ELECTRODE CAP AND THE TUBE AXIS BY AN ANGULAR TOLERANCE OF ±10° MEASURED ABOUT THE TUBE AXIS.

NOTE 3: THE AXIS OF EITHER DUODECAL BASE WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE AXIS OF THE TUBE ENVELOPE.

BASING DIAGRAM



WRITING SECTION

End View of Duodecal 7-Pin Base Depicted by Solid Lines

PIN 1: HEATER
PIN 2: GRID NO.1
PIN 6: GRID NO.3
PIN 7: NO CONNECTION
PIN 10: GRID NO.2
PIN 11: CATHODE
PIN 12: HEATER
CAP ON WRITING GUN SIDE OF FLANGE (Cap located on side of tube opposite base key): GRID NO.4, EXTERNAL CONDUCTIVE COATING

READING SECTION

End View of Duodecal 6-Pin Base Depicted by Dashed Lines

PIN 1: HEATER
PIN 2: GRID NO.1
PIN 6: GRID NO.2
PIN 10: NO CONNECTION
PIN 11: CATHODE
PIN 12: HEATER
C: EXTERNAL CONDUCTIVE COATING

TARGET SECTION

FLANGE: BACKPLATE
CAP ON READING GUN SIDE OF FLANGE (Cap located on side of tube over base key): SHADING ELECTRODE
CAP ON READING GUN SIDE OF FLANGE (Cap located on side of tube opposite base key): OUTPUT-SIGNAL ELECTRODE

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